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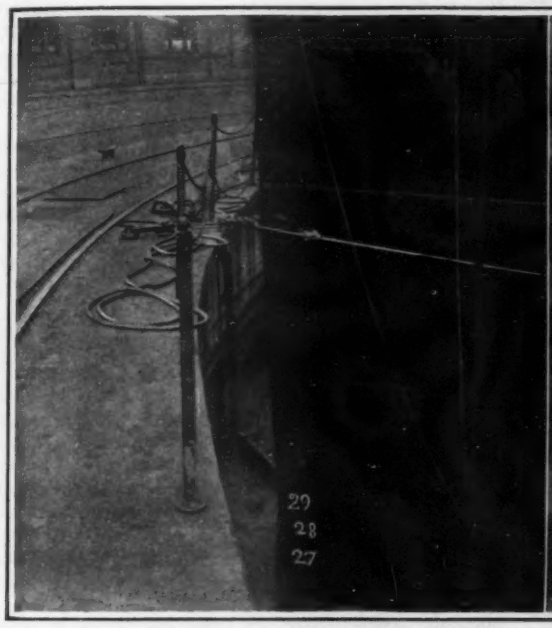
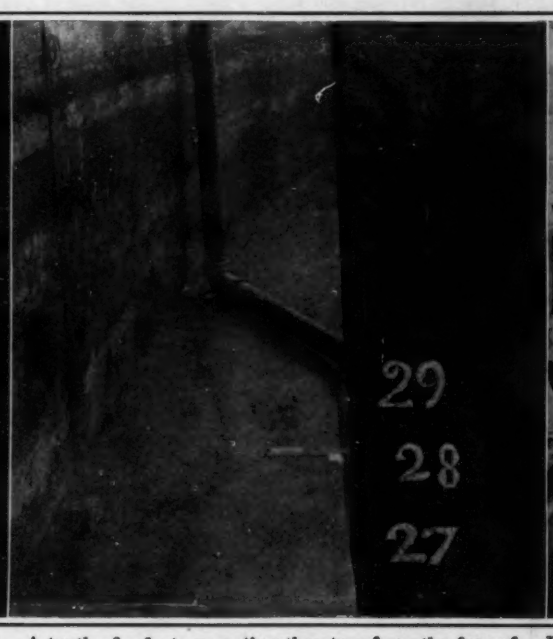


Clearance between the stem of the "Kaiser Wilhelm II" and the head of the dock



A tenth of a foot separating the stem from the face of the altar at the head of the dock

How the point of the stern projected into the caisson, the rudder being swung 60° to port to clear

"693 in 691"

By H. C. Hardy

"PROBLEM. *Given one ship 693 feet long overall, and one dry dock, designed to accommodate vessels not over 691 feet long, to dock the ocean liner in question successfully and without injury to dock or hull.*"

If this problem were part of a civil service examination for engineers, a commission on the sanity of examiners would seem next in order. Yet exactly that problem was put up to the government engineers when it became necessary to put the "Kaiser Wilhelm II" of the North German Lloyd line in dock for cleaning and inspection and any repairs which docking might reveal as necessary.

The dock is a part of a United States Government establishment "Somewhere on the North Atlantic Coast," maintained by the Bureau of Yards and Docks, Navy Department. It has a 10-foot margin allowed for clearance, so the problem, stated in exact terms, resolved itself into the apparently impossible one of putting 693 feet of ship into the 691 feet of space between the head of the dock and the caisson closing it.

This seemingly impossible problem was nevertheless solved. The authorities modestly confess that a certain element of luck aided the ingenuity and care used in the operation, but the successful termination of this operation, which might truly be regarded as an engineering adventure rather than as an experiment, shows that engineering skill of a high order rather than chance was the deciding factor.

To those who are uninitiated in the ways of ships and docks it must be explained that the process of docking a large vessel, while simple in essentials, requires a high degree of skill properly to accomplish. The ship to be docked is warped into the dock, towed very slowly into position by the use of power winches, and moored in such a position that when the water is taken from the dock it will rest on an even keel in the proper position. As the water is pumped out, struts and braces are applied from the steps of the sides of the dock so that when the dock is finally dry, the ship is well supported at all points.

Had there been plans available of the "Kaiser Wilhelm II" the problem might have seemed less difficult. Unfortunately, her German owners had not been thoughtful enough to leave a set on shipboard and there seemed insuperable difficulties in getting them from Berlin. So the services of a diver were employed, the ship lying at a berth in the yard in question, and he made as accurate measurements of the hull as it was possible to do under water. It was from these measurements that the engineers in charge came to the conclusion that the much-in-the-way extra 2 feet of ship could still be accommodated in the 691 foot space.

When the "Kaiser Wilhelm" was in position, her stern nosed the head wall of the dock with a clearance of 0.1 of a foot. The caisson then had to be put in place, and here was where the calculations, measurements and skill came into play. A dock caisson is, to the layman, a ship in itself. That is, it is a structure designed to resist great lateral pressure, it has flotation, and can be raised and lowered by pumping water into and out of it. Its purpose is to act as the gate in a canal lock acts—to hold water back.

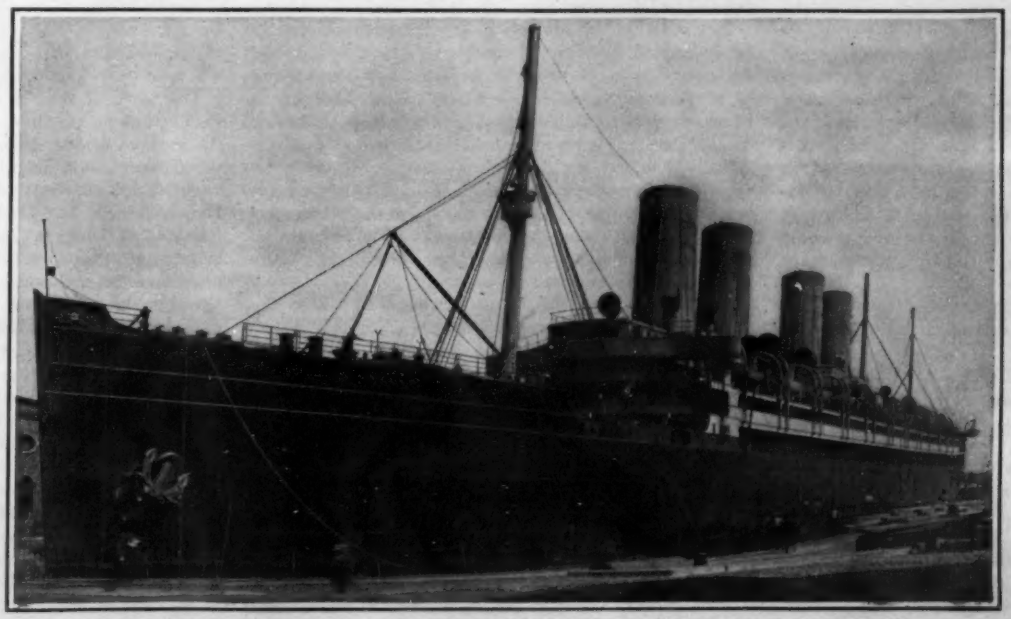
In ordinary cases, the caisson is simply floated into position so that its foot will sink into the recess in the bottom of the dock provided for it. But here, with not only an absence of clearance but with 2 feet of ship for which there was no space, this could not be done.

Yet the caisson *had* to be in position before the water could be pumped out, and while the measurements had shown that, once in position, the overhanging stern would barely clear the caisson shelf by fitting in between the braces, the problem was to get the caisson under the overhang.

But the job was done. By towing the caisson into position (the ship's rudder had been turned to a 60-degree angle to get it out of the way) and partially submerging it, and then *tilting* it, it was edged in under the stern and fitted into its grooves. That the overhang actually *touched* the caisson shelf at this stage of the operation proves the narrowness of the margin which made the job possible.

The non-technical reader should understand that in dealing with a 20,000-ton ship forces are brought into play which require the most delicate handling. A single slip at any stage of the game may cause not only damage to the structure but a possible loss of life, both on the part of those doing the work and those who will afterwards depend on the seaworthy qualities of the ship for safety. A ship is a structure designed to be supported everywhere—the water which upholds her provides a foundation for her stability. Remove this, and she becomes helpless as far as remaining an entity is concerned—

(Concluded on page 181)



The "Kaiser Wilhelm II" snugly fitted into a dry dock "somewhere in the United States"

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

To the Kaiser

YOU are doubtless aware that in recent issues of the "Public Ledger" of Philadelphia, our late Ambassador to the German Imperial Court, the Hon. James W. Gerard, has been publishing a series of articles under the caption, "My Four Years in Germany."

You will readily understand that, in view of the political events covered by that period, these disclosures have a very vital interest for the American people; and none of them more so than the record of our Ambassador's interview with you at Charleville, touching the matter of your ruthless submarine warfare against peaceful merchant shipping.

In the particular interview referred to, you stated that the submarine had come to stay; that it was a weapon recognized by all countries; and that you had seen a picture of a proposed giant submarine in an American paper, the SCIENTIFIC AMERICAN. The giant submarine, as you are doubtless well aware, is still in the theoretical stage, and you probably will agree with us that it is likely to remain there for some time to come, if not, indeed, indefinitely.

The predisposing motive of the present comment upon your interview is to be found in the sentence following the one just quoted, which reads, "He," that is yourself, "added that there was no longer any international law." We shall entirely agree with you in this statement if you will modify it to read, "There is *for Germany* no longer any international law"; for we Americans, in common with all the civilized nations of the earth, have come to realize that, in place of that carefully and laboriously constructed code of principles and practices, which is known as international law, you have substituted a policy of cynical expediency and opportunism, according to which you are a law unto yourself; that you consider any and all practices which conduce to the military welfare of Germany to be justified by the very fact that they so operate. It was your wholesale repudiation of international law and particularly of such laws as were designed to protect civilian non-combatants, that has drawn the American people into the present august array of the civilized world against yourself and those of your advisors who have promoted and let loose this greatest of the world's tragedies.

So far as the entrance of the United States into the war is concerned, it was your crowning breach of the international code as represented by the killing of American civilians in the present submarine warfare, that has brought the whole American people into a grim and determined conflict with yourself and those principles of international lawlessness under which you and the military party in Germany are now operating. This was the immediate cause; but we are free to admit that the crisis produced by this last breach of the international code was merely the climax to a state of cumulative moral indignation, due to the ever-growing evidence that, in every case where it suited your military purpose, you were prepared to flout the whole civilized world by casting the international code to the winds. In proof of this we invite your attention to the following notable transgressions:

1. In repudiating the sanctity of the written word by referring to a time-honored treaty as a "scrap of paper," you have overthrown one of the great foundation stones of modern civilization.

2. You have sanctioned the levying of huge monetary assessments against helpless victims of your aggression, and the holding of civilian hostages as a guarantee of their payment.

3. By that silence which means consent, you have encouraged the theft of private property from the homes of non-combatants in countries which you have invaded; and this burglary has not been confined to the ranks, but has been openly practiced among high ranking officers of your army.

4. You have outraged civilization by a system of organized destruction of property which represented no conceivable military advantage, in the course of which some of the world's choicest historical monuments have been deliberately and systematically destroyed.

5. You have cruelly broken down those humanitarian safeguards which civilization throughout the centuries has carefully built up around the non-combatant population of war-ravaged countries; for you have persistently dispatched your aircraft to attack non-fortified cities from the sky, and you have not hesitated to send your ships of war to bombard sea-coast pleasure resorts, which had not, and which you were well aware did not possess any coast fortifications or any form of coast defense whatsoever.

6. You have gone back into the remote past, to the centuries antedating all civilization, for your inspiration in reviving and sending forth at the head of your invading battalions the long-buried monsters of frightfulness and terrorism. The story of this savagery is written large upon the plains of Belgium and France, and a searching analysis of what happened in the early days of this war has convinced the nations which are leagued against you, ourselves included, that the rape, arson, pillage and executions of that black page of your military history were not due to an ignorant and excited soldiery, but received undoubted sanction in the highest military quarters.

7. Also, in your deliberate revival of the worst horrors of ancient warfare, you have not hesitated to resort to the seizure and carrying off as bondsmen of the non-combatant population.

8. Lastly, while you were carrying upon your lips fair phrases about the "freedom of the seas," you have endeavored in your ruthless submarine warfare to establish upon the seas a tyranny of intimidation and bloodshed which is unparalleled in all history for its magnitude and fury. As a close student of naval history, you know full well that it has ever been the proud boast of the naval service, that its fierce and dashing valor has been tempered by a noble chivalry. It has been reserved for you to blacken this fair record by a wholesale slaughter of unoffending men, women, and children, for which not even the crimes of a Morgan or Captain Kidd provide a parallel.

Thus have you proved during the past three years that, for yourself and those who immediately surround and advise you, there is "no longer any international law"; and it is largely because we, among the other free peoples of the world, believe that the principles of international law were never so binding and their safeguards never so urgently called for as now, that we have joined that great league of civilisation, whose object it is to vindicate these principles by making this world of ours "safe for democracy" for all time to come.

The War and British Industries

THE struggle between Britain and Germany for military supremacy had a more or less industrial beginning and has already led to many results in that field. Among these we find particularly the establishment of a far greater degree of industrial home rule than England has ever before enjoyed. One of the most important steps leading to the wresting from Germany of the commercial supremacy which she has so long enjoyed in many important trades was an exhibition of German and Austrian goods which was held recently in the larger Midlands cities, at which it was possible for the English manufacturers to see and handle comprehensive collections of samples of the many products of the Central Empires.

As a result of this exhibition, new factories will shortly be completed in Wolverhampton for the manufacture, on a large scale, of wrought enameled hollow-ware and of artificial silks. In another part of the Midlands a brush-making machine formerly controlled altogether by the Germans is being manufactured, while a welcome stimulus has been given the glass industry, especially the making of flint glass. In the Sheffield district very important developments have been made in the heavy steel industry, and it seems that electrically melted steel from this region will play an important part in the future struggle for supremacy.

At the beginning this boom was handicapped by the total lack of any source of tungsten supply. While military considerations make it impossible to state definitely how this deficiency was made up, we can assert that there is now an ample supply for all needs.

In the making of dyes the British chemists are doing as well as could have been hoped for. At least one dye which the Germans were very confident could never be produced by any one but themselves is being turned out by two entirely independent British firms. An analogous triumph is the making of gelatine in sheets by a Belfast concern, in spite of the very widespread conviction that German methods here could not be duplicated. Even in the making of lenses the British both duplicated German work and evolved an improved type of lens for the special work of photographing from aircraft, which has enabled the members of the Royal Flying Corps to obtain pictures superior to any work which the enemy could execute.

Altogether, it begins to appear that Germany was entirely too light-hearted in her assumption that her trade would be but temporarily alienated by the disturbance of the war.

Magnetic Research at Sea

THE Department of Terrestrial Magnetism of the Carnegie Institution of Washington is carrying out one of the most important international undertakings in the history of science. Its significance is practical as well as academic.

We have frequently referred to this establishment—notwithstanding the heavy expenditure of ink, paper and time entailed in printing its sesquipedalian name. We take pleasure in returning to the subject at this time in view of the recent appearance of a monumental volume of the department's *Researches* (Volume III), presenting in minute detail a report on the ocean magnetic observations from the beginning of the work in 1905 down to the year 1916. The data contained in the new volume are of special value for the reason that, while thorough magnetic surveys have been conducted over many large areas of the land, there has heretofore been a serious dearth of such work at sea—where, in general, it may be said to have been most needed. In the United States, for example, the Coast and Geodetic survey occupies about 265 new magnetic stations every year, and has at present about one station for every 600 square miles of our continental area, exclusive of Alaska. At sea, however, this branch of the Government has been able to measure the magnetic elements only along the coasts, and in a desultory way.

The pioneer in magnetic surveying at sea was Edmund Halley, who was placed in command of the "Paramour Pink" by King George III for the purpose of "proceeding with her on an expedition to improve the longitude and the variation of the compasses". Between 1698 and 1700 Halley made two voyages in the Atlantic Ocean as far south as latitude 52°S. He measured only the magnetic declination, as no instruments were then available for measuring dip and intensity at sea. The results obtained on these voyages—the first ever undertaken for purely scientific purposes—combined with data collected incidentally by mariners in other parts of the ocean, enabled Halley to publish, in 1701, the first general chart showing lines of equal declination (now, but not in Halley's time, called *isogonic lines*).

The first elaborate attempts to measure all three magnetic elements at sea were those successfully carried out on the expeditions of the "Erebus," the "Terror," and the "Pagoda" in the years 1840-45, chiefly in the southern oceans. The Fox dip-circle for measuring magnetic inclination and intensity at sea had then just been invented. "This most carefully executed work," says Dr. Bauer, "was done under the direction of Sabine the famous English magnetician. . . . Not only was the work ably directed, but the commanding officers of the vessels . . . were most zealous and painstaking. The attempt was made to obtain full series of observations daily, and these were secured at times under great physical difficulties" . . .

During a circumnavigation of the globe in 1857-60, the Austrian man-of-war "Novara" made a valuable series of declination measurements. All three elements were measured regularly in the course of the "Challenger" expedition (1872-76) and the German "Gazelle" expedition (1874-76). Some good series of observations have also been made by recent Antarctic expeditions.

Nevertheless, when the "Galilee," the first of the Carnegie vessels, began her work in 1905, our knowledge of the distribution of magnetic forces over the oceans was extremely fragmentary.

The work of the "Galilee" was done wholly in the Pacific, and on her three voyages between 1905 and 1908 she covered 63,834 miles. In 1909 she was replaced by the unique non-magnetic yacht "Carnegie." This vessel has been employed on the Atlantic, Pacific and Indian Oceans, has penetrated the Arctic as far as the north of Spitsbergen, and has skirted the Antarctic in the neighborhood of 60° south. When her present cruise has been completed, about the end of this year, the aggregate length of the cruises of both vessels will amount to about 255,000 nautical miles. These remarkable expeditions together with the activities of the Carnegie and other observers on land, will make it possible for the Institution to publish some time in 1918 new magnetic charts of the world, far surpassing in accuracy any now in existence.

The urgent importance of providing mariners with more accurate magnetic charts is clearly evident from the magnitude of the errors in existing charts already revealed by the work of the "Galilee" and the "Carnegie." In certain parts of the Pacific and Atlantic Oceans the errors in declination have been found to be 4 degrees; in the Pacific Ocean, 6 degrees; and off the southwest coast of Australia from 12 to 16 degrees!

Electricity

The Corrosion of Cast Iron.—A paper by E. A. and L. T. Richardson in the *Preceedings* of the American Electrochemical Society dated May 25th last, discusses the value of cast iron as a rustproof material. For many purposes cast iron is in this respect preferable to steel. Instances are on record of cast-iron objects having remained in good condition though subjected to corrosive influences for many years, and underground it is usually superior to other kinds of iron. Its behavior in this respect is contrary to the theory of electrolytic corrosion, according to which cast iron, being less homogeneous than steel or pure iron, should rust faster. It is possible that, although the initial rusting is largely determined by electrolytic action, other factors, such as the adherence of the coating of rust and the protection given thereby, have an important bearing on the subsequent resistance of the material to corrosive influence.

Death of Professor Ganz.—On July 28th Albert F. Ganz, professor of electrical engineering and dean of the Senior class of the Stevens Institute of Technology, died at his home in Hoboken, N. J. Professor Ganz was born in Elberfield, Germany, April 25th 1872, and came to the United States with his parents in 1881. He entered Stevens Institute as a member of the Sophomore class in 1892 and was graduated in 1895 with the degree of mechanical engineer. It was then that he was appointed instructor in applied electricity. Two years later he held the chair of assistant professor of applied electricity and physics, and in 1902 he was appointed professor of electrical engineering and head of the department, which post he held until his death. Professor Ganz devoted considerable attention to the study of electrolysis and the corrosion of underground metallic structures, and he was considered an authority on this most important subject.

Air-Blast Rectifier for High-Tension Alternating Currents.—In the *Physical Review* Messrs. E. R. Woolcot and C. J. Erickson remark that partial rectification of a high-tension alternating current occurs on the passage of a discharge from a point. This fact has been known for years, but there is difficulty in making use of this effect in practice, especially if a considerable current flows. The authors have found that complete rectification and smooth operation can be obtained by utilizing a current of air flowing from a point to the plate. An apparatus is described making use of this principle, and oscillographic curves are reproduced to illustrate the effect produced. The discharge when rectification occurs is quite rhythmic and snappy as distinct from the colored arc, which results when no air is flowing. Difficulties are experienced at relatively low voltages. Some good results are recorded with about 15 kv. and 12 to 25 milliamperes flowing, and up to 350 kv. and a frequency of 500 cycles per second satisfactory rectification was secured.

What is "Cross-Talk?"—The following definitions of cross-talk, over-hearing and secrecy have been framed by the Telephone Manufacturers' Association, and approved by the Institution of Electrical Engineers of Great Britain: "Cross-talk" in telephone systems is the unintentional overhearing between one circuit and another not due to any such metallic connection as arises from accident or is effected by a user or third party. In practice the "cross-talk" may be due to disturbances arising from electro-magnetic or electrostatic induction, to leakage, or to insufficient conductance, in a common portion of circuits. "Secrecy" in telephone systems is secured by an arrangement of circuits making it impossible for a third party by any normal use of the system to cut in and listen to the conversation taking place between two users, at any rate, without the knowledge of the parties conversing. The term "secrecy" must not be confused with freedom from "cross-talk."

Arcs Under Pressure.—Recent improvements in searchlights have taken the form of various methods of cooling the electrode with a view to obtaining greater local concentration of light, either by a spray of alcohol, or, as in the Sperry searchlight, by a blast of air, according to the London *Electrician*. Another line of development being investigated in Germany has been the use of arcs under high atmospheric pressure. Lummer was reported to have obtained promising results shortly after the outbreak of the war, and it was thought possible that a considerable improvement in the efficiency of arc lamps and projectors might be secured in this way. According to some experiments described by Mathiesen in the *Elektrotechnische Zeitschrift*, this anticipation is not being realized. Pressures varying from a vacuum up to five atmospheres compression were utilized, both with inclined and vertical carbons. In the former case a marked gain in efficiency was secured, but the arc was found to become very unstable for pressures exceeding one atmosphere. On the other hand, with vertical carbons more stable conditions are realized, but the gain in efficiency seems to be moderate.

Science

Wild Substitutes for Domestic Plants.—One of the projects outlined by the committee on botany of the National Research Council is the search for wild plants which may be used as wartime substitutes for the more costly crop plants. During the Civil War Dr. John Porcher, a southerner, published a book giving a list of wild plants of the South which could be substituted for much needed food and drug plants. *The American Botanist* (Joliet, Ill.), proposes, with the aid of its readers, to compile a similar list. Information is sought as to any plants not ordinarily cultivated which have edible fruits, seeds, roots, etc. It is suggested that valuable knowledge on this subject might be obtained from hunters, trappers, woodsmen, farmers, Indians and the foreigners who pick up considerable food from the countryside. Similar information is desired concerning plants that can be used in medicine.

Detecting Adulteration in Tea.—A new method of detecting adulteration in tea has been described by L. Rehfous in the *Bulletin* of the Botanical Society of Geneva (Switzerland). It involves an examination of the stomata, which are quite different in *Thea sinensis* from those of the leaves used for adulteration. In *Thea* the guard-cells of the stomata possess, on their inner surface, a very strongly marked layer of cutin, which is prolonged into a beak or hook, and which is distinct from the beak which closes the ostiole. Mr. Rehfous finds these features, with minor variations, in all of numerous kinds of tea examined, and they appear even in the sepals of the tea plant. The only leaf used for adulteration that bears much resemblance to *Thea sinensis* is the leaf of Camellia (also a species of *Thea*), but a transverse section of the latter shows that the hooks of the stomata are very slightly developed.

English Names of Plants.—Mr. J. Adams, of the Central Experimental Farm, Ottawa, Canada, has recently put forth a suggestion which is so obvious and important that one finds it difficult to understand why it was not made the subject of an active propaganda long ago. Botanists, and many persons who are not botanists, realize that the popular nomenclature of plants in this country is in a state of chaos. The same species bears, in many cases, a score or more of different names, and, conversely, the same name is in many cases applied to a great number of different species. The latest approved Latin name is, of course, unequivocal, but even the Latin nomenclature is greatly confused, owing to the extensive list of officially abandoned but actually more or less widely used synonyms. Why should not the English name of each species be the subject of formal agreement among botanists, just as the Latin name is? Mr. Adams urges that a provisional list of English names of species be adopted for the United States and Canada, without waiting until all the fine points in taxonomy are settled. The English name should be applied to aggregate rather than segregate species; thus pipsissewa, or prince's pine, should be regarded as the name of both *Chimaphila corymbosa* Pursh and *C. occidentalis* Rydb., the two species into which *C. umbellata* Nutt. has been split up in the "North American Flora."

The MacMillan Expedition.—The MacMillan party, whose progress in exploding the mirage of "Crocker Land" we have reported from time to time, has finally been relieved and brought back to civilization, bringing intact a four years' collection of scientific data and exhibits which may well be characterized as priceless.

Full particulars of the Crocker Land hallucination are now available for the first time. It appears that this name was attached to a mirage of unprecedentedly lifelike appearance. Not only did it completely deceive Peary upon the occasion of its "discovery," but it repeated itself for the benefit of the MacMillan expedition, the members of which were for four days certain that from their observation post near Etah they were within sight of high ground covered with vegetation. Eventually, however, the true character of the phenomenon was revealed, and its cause concluded to lie in the presence of sharply marked layers of air at different densities.

Even greater permanent scientific importance is to be attached to the work of the expedition along the eastern shore of Ellesmere Land during the present year. Complete surveys were made, two new islands charted, and two old ones found to be among the missing. This, in connection with the discovery of the immense "American Museum Glacier" and the concrete results of the coast survey, establish rather conclusively that the Ellesmere shore regions have been in a state of tremendous galcial activity since 1850.

Interesting sidelights on the enterprise are afforded by the statement that the arrival of the relief ship in Sydney settled a controversy of two years standing between the members as to whether the Germans had taken Paris, and that Mr. MacMillan is tremendously keen about the possibilities, indicated in these columns some months ago, of the aeroplane as a means of Arctic exploration.

Astronomy

Meteor Observations in 1916, sent in to the Leander McCormick Observatory for discussion and publication by amateurs in the United States and Canada, numbered more than 10,000. This is said to be the largest number of meteor observations ever collected in a single year, except possibly during the years of a remarkable meteor shower.

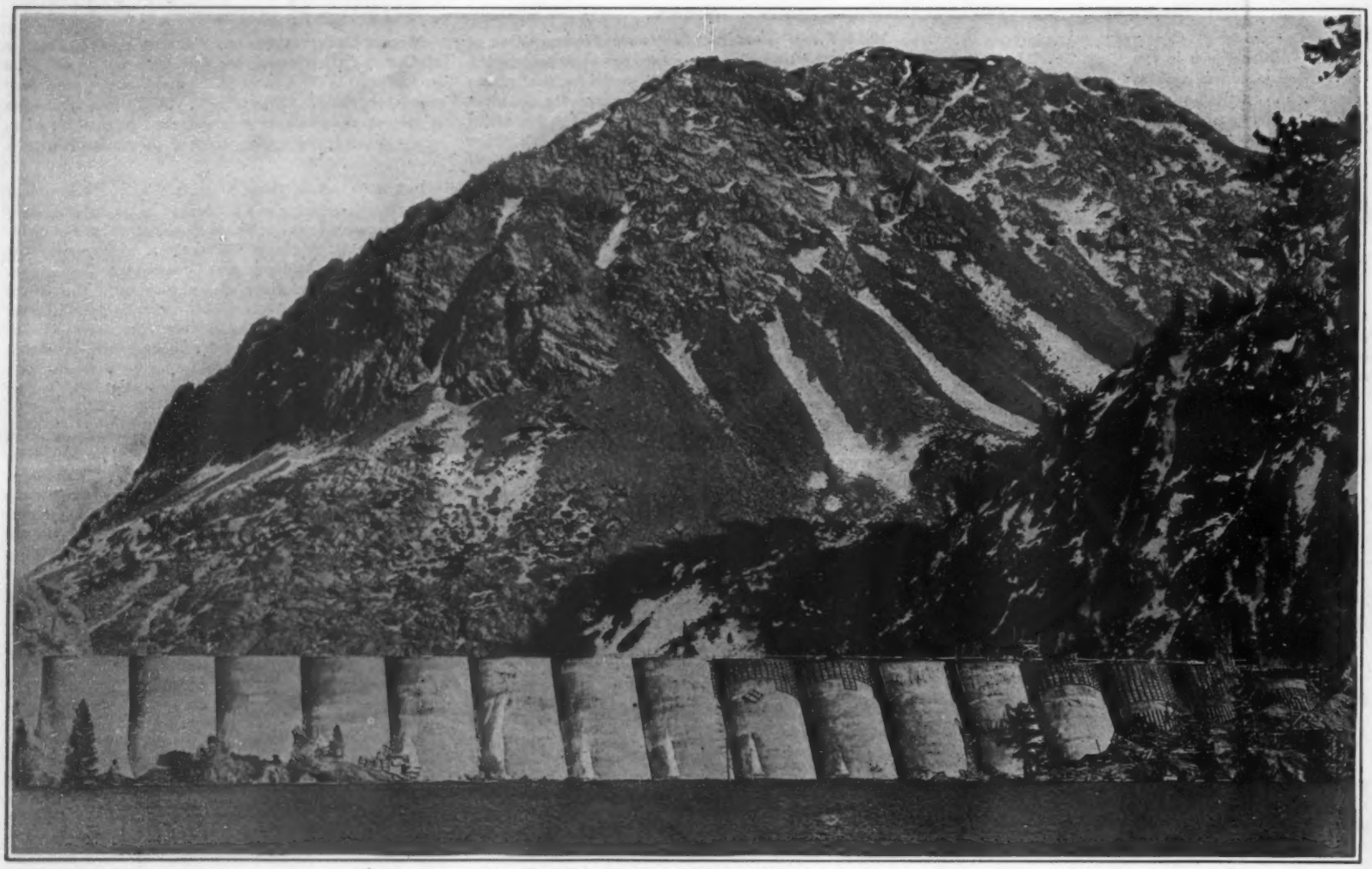
Lag in Wireless Time Signals.—The refinements of modern time-keeping are illustrated in an investigation recently carried out by Mr. F. D. Urie, under the direction of the U. S. Naval Observatory, to determine the lag between the Arlington and Great Lakes time signals, both of which are received by wire from the Naval Observatory and converted automatically into wireless signals. Between Washington and the Great Lakes station there are 800 miles of telegraph wire, involving several make-circuit relays. The lag between the two radio stations was found by a series of tests to average 0.085 second, with a probable error of 0.002 second.

The Origin of Meteors.—An old hypothesis as to the origin of meteors has recently been revived by M. Émile Belot, who suggests in the *Comptes Rendus* that these bodies may be the product of volcanic eruptions on the moon and on the satellites of other planets in the solar system. He states that a velocity of projection of the same order as that which has been observed in the eruption of Cotopaxi, and only twice as great as that realized in modern artillery, would suffice to carry a body free from the moon. He presents calculations as to the speed of projection and other conditions under which such a body would become, respectively, a satellite of the moon, the earth or the sun; also calculations relating to the orbits of volcanic material expelled by other satellites.

A Catalogue of Double Stars discovered in recent years has been published by the Royal Astronomical Society as Volume 61 of its *Memoirs*. This list was prepared by M. Robert Jonckheere, director of the observatory of the University of Lille, who, on account of the war, has been living for some time in England. In addition to the numerous discoveries and measurements of M. Jonckheere, made at Lille, and lately with the 28-inch refractor at Greenwich, the catalogue contains all double stars discovered down to the year 1905, and not included in Burnham's general catalogue published in 1906, and all pairs discovered since that date down to the end of 1916. No doubles are included having a separation greater than 5 seconds. The catalogue comprises 3,950 stars.

The Solar Eclipse of May 29th, 1919.—At the request of the Astronomer Royal, the Royal Astronomical Society, of London, has undertaken to collect information concerning climatic and other conditions along the path of the total solar eclipse of May 29th, 1919, for the benefit of expeditions that may be organized. This eclipse will be of special interest on account of the long duration of totality, and because the sun is, at the moment of eclipse, in the midst of a group of bright stars, which will provide an excellent opportunity of determinining whether light-rays passing near the sun are deflected in accordance with the gravitation theory of Einstein; a question which is at present arousing much interest among astronomers. The path of the eclipse passes over the basin of the Amazon, the Atlantic Ocean, and the basin of the Congo, as far as Tanganyika. According to the *Geographical Journal*, possible stations would seem to be in the state of Ceará, Brazil; the island of Principe; in the neighborhood of Libreville, French Congo, and on the western escarpment of Tanganyika. The *Journal* for last April contains a good deal of preliminary information about the climate and facilities of these regions.

Methods of Photographing Jupiter.—Mr. J. H. Reynolds has described to the British Astronomical Association the methods by which he obtained a number of exceptionally fine photographs of Jupiter during the last opposition. His instrument is a 28-inch reflector, used in the Cassegrain form. The primary focus of the 28-inch mirror is 10 feet, but the convex mirror increases this to 55 feet equivalent focus. The rays are brought to the side of the framework of the telescope by a 45-degree plane mirror, placed about 2 feet in front of the large mirror. They are then intercepted by a Cooke photographic Barlow lens, which increases the virtual focal length again from three to six times, according to its position. The 5 x 4 plate is in a plate holder which can be moved in a slide in the direction of right ascension, and from 12 to 18 images are taken on one plate. To improve the definition the aperture was cut down to 22 inches. The rapid rotation of the planet itself puts a limit to the time of exposure; not more than 10 seconds can be given, using Imperial extra rapid plates. At the 1916 opposition the north temperate belt of Jupiter, which was absent in 1915, had reappeared almost equal in strength and size to the south temperate belt. Between it and the north tropical belt was a remarkable series of bright elliptical formations, which Mr. Reynolds says were probably in the nature of cyclones.



The Gem Lake multiple arch dam, almost completed

The Multiple Arch Concrete Dam

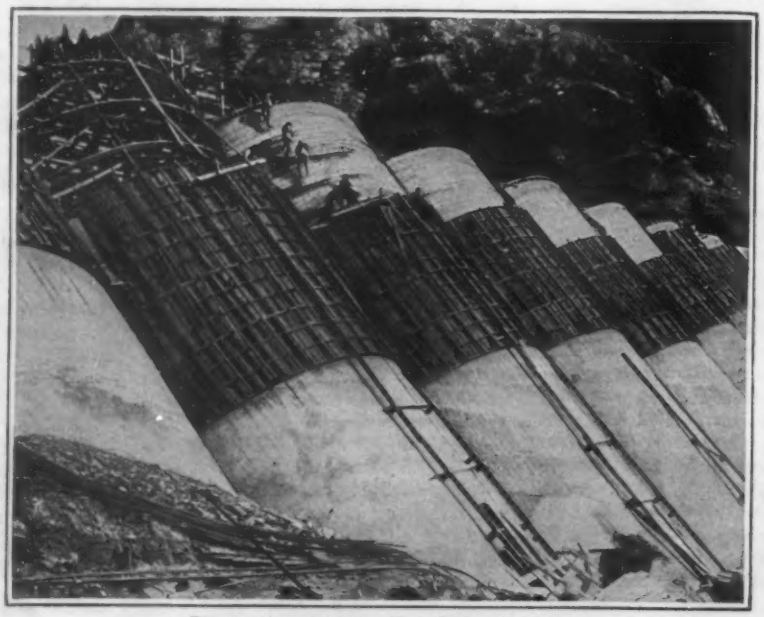
A New Type of Construction Much Used in Western Hydro-Electric Work

THERE are dams and dams. The type which we see in the comparatively small water-power and water-storage sites scattered so freely over the country-side consists simply of a wall of masonry or concrete—in earlier days, even of wood—running straight across the waterway, and restraining the water by its weight alone. A modification of this type which has been made very familiar by its use upon such great undertakings as the Roosevelt and Arrow Rock dams is the arched dam. Instead of running straight across, the barrier takes the form of an arch lying on its side, convex face upstream. By means of the very nature of the arch, such a dam transmits a large part of its load to the buttresses and foundations. It does not depend wholly upon its weight to resist the thrust of the water; it adds to that weight the arch action.

An excellent example of the use of the arch property to restrain water was to be found in the difficult work connected with the removal of the bench in the deep tunnel under the East River from Astoria to the Bronx, where it was desired to lay down a concrete blanket to resist the upward thrust of water under considerable head. There was insufficient room for a blanket that would provide the required resistance by virtue of its mere weight, so the concrete was laid in the form of an inverted arch. In this way much of the load was transferred to the immovable rock at the sides of the excavation. The principle of course is identical with that of the ordinary arch dam.

There are cases, however, where a single arch would be impracticable because of expense or local conditions. In some of these cases the multiple arch construction may be used. In fact, where a multiple arch dam is suited to the requirements, it is often found more economical than a single arch structure, so that within the range of sizes to which it is applicable this newer type is a formidable competitor. The principal limiting factor is the height. With a slope of 50 degrees the crown of each arch will be 0.84 feet farther forward at the crest than at the base for each foot of height; and the buttresses necessary to support this leaning structure will have to be very large and the bracing highly elaborate. Eventually a limit of height is reached where it will be more economical to throw a single arch across the cañon, unless the latter is very wide indeed. Naturally, this limit will vary with the conditions. It is anticipated, however, that the multiple arch dam will find its usual applications where the height is to be less than 130 feet.

A multiple arch dam demands a good foundation. The buttresses support the dam, and they in turn must be properly maintained by the foundation of bed rock or other suitable material. The settling of a single buttress may lead at once to settling and collapse on either side. When there is doubt as to the excellence of the foundation available, recourse is usually had to the earth-fill dam like that at Gatun, where between two parallel and widely separated ridges of rock an enormous mass of earth was washed into place by means of pipe-line dredges, somewhat in imitation of the terminal moraines which restrain the Great Lakes on the south. A further alternative where earth filling is not accessible is the rock-fill dam.



Placing forms for the Gem Lake structure

The object in using some such inclination as 50 degrees is partly to reduce the shearing stresses on the buttresses. In selecting the horizontal angle to be subtended by the several arches a consideration is the volume of material required. The angle which gives an absolute minimum of concrete used is 133½ degrees; but by reducing this angle to 120 degrees the thickness of the arch can be increased six per cent while the volume of concrete is augmented only one per cent. This is distinctly an object to be sought, since otherwise the thickness near the crest is apt to be too small in comparison with the length of the arch.

After the several arches are completed, which will ordinarily take place toward the end of the warm season, temperature stresses are to be looked for, particularly if the dam remains "unloaded" during the ensuing cold weather. These will be especially acute on the convex side near the crest, and at the abutments on the opposite, down-stream face. The reinforcement is placed accordingly. It is to be expected that, even if at a certain degree of temperature cracking occurs despite these efforts, the cracks will close once the dam gets the weight of the water against it. In fact, the reinforcement ceases to be of any special value in the resistance of temperature effects after the load is on.

In actual construction it is convenient to build the buttresses first, then the arches. The latter are tied to the former by means of suitable steel members imbedded in the concrete. That is to say, when a buttress is built certain reinforcement is left projecting out from the general mass. If one arch should fall, there is reinforcement present in or on the buttress to resist the collapse of adjacent arches. This function of limiting the possibilities of collapse is the principal duty of the buttress reinforcement, although it does serve in addition to prevent cracks and, to some extent, to resist shearing stresses. There is also a certain amount of reinforcement used in the buttress near the down-stream edge for the purpose of overcoming wind pressure and again for the prevention of cracks.

It will be understood that in constructing a multiple arch dam, it will by no means always be the case that the foundation

will be a level surface extending from one side of the waterway to the other. There may be a great deal of irregularity. In consequence, the several arches will reach down to different levels in the cañon bottom. Viewed from up-stream, a completed dam will present the appearance of a group of big parallel pipes extending out of the ground and inclining away from the observer. Not infrequently, as with all dams, there will be a road across the top.

One of the power companies on the Pacific Coast has multiple arch dams on Rush Creek, Mono County, Cal. At Lower Gem Lake a dam 700 feet in length stretches across the canon in 17 arches of standard span 40 feet. At the extreme end of the dam two of the arches constitute the spillway section. From the lowest point in the foundation to the level of the crest is 112 feet. While the bedrock was mostly clean and bare, just as the glacier left it, there was some excavation required where a slide had occurred at the north abutment, and at one or two points

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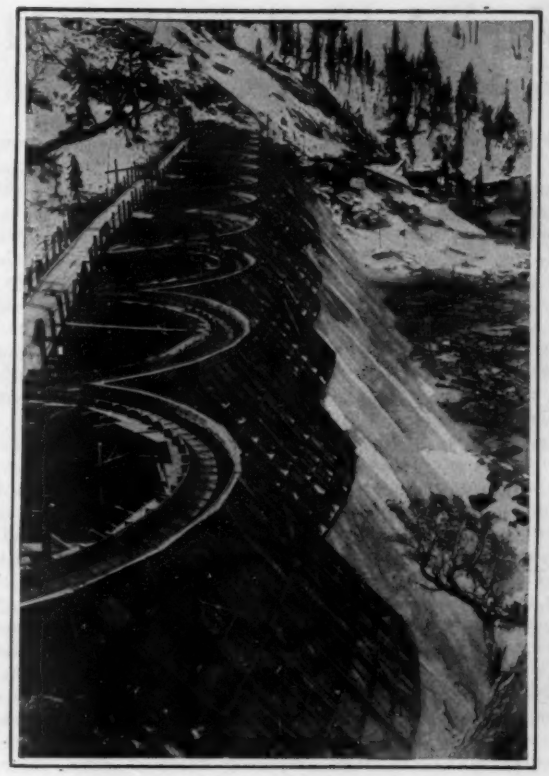
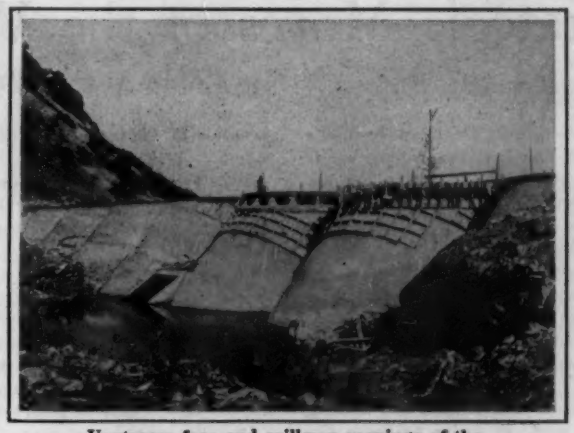
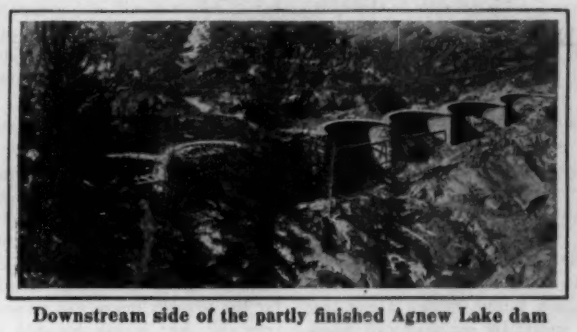


Work at the crest of the Gem Lake dam



Upstream face and spillway openings of the Agnew Lake dam



Downstream side of the partly finished Agnew Lake dam

Chemical Products From the Forests

By Dr. A. W. Schorger

THE forests contribute annually over four million cords of wood as raw material to the pulp and paper industry, over a million cords to the hardwood distillation industry, over a million cords of bark and nearly a million barrels of extract to the tannin industry, nearly five million barrels of crude gum to the naval stores industry; besides raw material for many smaller chemical industries. The majority of the products of these industries are extremely practical, frequently amounting to absolute necessities; for example, the use of wood pulp in all kinds of paper, in fiber containers, textiles, and in the production of viscose silk. Charcoal is used in blast furnaces for the production of pig iron, in gun powder, in chicken feed, in the manufacture of carbon bisulphide and indirectly carbon tetrachloride; wood alcohol is used in the coal-tar dye industry, in the manufacture of photographic films, as a denaturant for grain alcohol, and is the only source of formaldehyde used so extensively as a disinfectant; acetone is used in the manufacture of smokeless powder, and in the production of chloroform and iodoform; wood tars upon distillation yield a so-called "light oil" used in varnishes and paint and a "heavy oil" used in axle grease and for coating the interior of casks and barrels to render them impervious to liquids; tannin converts the raw hide into a durable leather; rosin is used in soaps and in size for paper, in the manufacture of linoleum, and in ship calking; turpentine is used as a thinner in paints and varnishes; various wood oils are used for medical purposes and in cheap perfumes. The United States has naturally occupied a preëminent position in several of the forest products industries by reason of our unusual resources, but this position can be improved by progressive and aggressive development of the industries. Dr. Kresse, in the SCIENTIFIC AMERICAN for June 16th, 1917, has pointed out briefly how the Forest Products Laboratory is aiding this development by investigating new supplies of pulp wood and improved methods of manufacture. Similar work is being done in the other industries.

Naval Stores

About seventy-five per cent of the world's supply of naval stores are produced in the Southeastern States from virgin stands of longleaf and Cuban pine which are fast disappearing. Neither operators nor consumers appear to be concerned about the future and in the characteristic American manner are leaving the National Government to do the worrying.

The present practice in making the weekly scarification which produces the flow of crude turpentine is to take off a streak of wood about one-half inch high. In order to increase the yields from the present stands experiments were made last year in reducing the weekly streak to one-fourth of an inch, and also making two streaks per week in place of one. By means of the narrow streak the face could be worked twice as long while by double chipping the height of the face would not be increased above that of the standard face, and at the same time it seemed probable that the method would result in materially increasing the yields, since 90 per cent of the flow of "gum" occurs during the first three days following chipping.

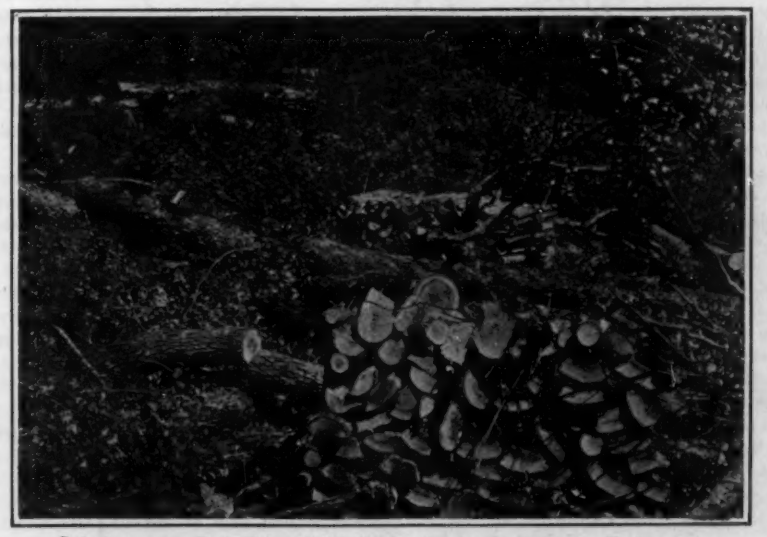
Narrow chipping gave yields probably too low to be profitable at the present time but the increase from double chipping was very satisfactory, showing a 30 per cent increase in yield of turpentine and 36 per cent increase in yield of rosin.

The actual cost of double chipping is twice as great as by the standard method and a few other increased expenditures are rendered necessary by the method. Allowing, however, for all possible increased expense, double chipping showed a handsome profit. The increased profit per crop (10,000 cups) was

1,007 gals. of turpentine at $0.40 per gal.	$ 402.50
38,003 lbs. of rosin at $5.00 per 280 lb. bbl.	678.80
Increased gross returns	1,081.30
Extra cost for using new method	631.60
Increased net returns per crop	449.70

Although indications are very favorable, it is possible that after the first season the double chipping may have reduced the vitality of the trees.

The same trees are being chipped for the second year at the present time to determine if the yield ratios will be maintained. Double chipping should be especially applicable in the case of lumber companies who desire to obtain maximum yields from their timber two or three years before cutting.



Inferior or small stuff (maple) left after logging operation. To be sent to distillation plant

Turpentine operations on small second-growth timber. Better to increase yields from large timber and save small trees for future operations

Distillation Industry

Most of the acetone used in the arts is made from the acetate of lime obtained from hard wood distillation, and has valuable solvent properties for the manufacture of explosives, certain of which are practically dependent upon this solvent alone. In the manufacture of acetone considerable amounts of higher ketones are obtained that are excellent solvents for pyroxylins and resin lacquers, but the oils must be carefully purified since they are exceedingly prone to assume a yellow color which is very undesirable. The laboratory has had some success in obtaining a colorless solvent by first hydrogenating the ketone oils at high pressures using nickel as a catalyst. Diacetone alcohol obtained by condensation of acetone with alkalies has been used for a long time on account of its valuable solvent properties. Considerable difficulty was at first experienced in obtaining a solution that would remain clear and colorless on standing, but these objections appear to have been successfully overcome.

Methyl or wood alcohol is easily oxidized catalytically to formaldehyde, a powerful disinfectant, which is used extensively in medicine but perhaps its most important use, particularly in view of the present food shortage, is in the sterilization of seed for agricultural purposes.

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Strategic Moves of the War, August 29th, 1917

By Our Military Expert

WHEN the fields of operations are considered, the history of the Great War has been rapidly made during the past week or ten days. Fighting has extended practically from the North Sea to Switzerland; the progress of the Italians on the Carso plateau in the direction of Trieste has shown the Austrian weakness. On the other hand the continued withdrawals of the Russo-Rumanian forces on the southern end and a similar withdrawal by the Russians on the Riga front leads to the belief that but little except defeat and possibly disaster for them can be expected on the eastern lines.

It is clear that the French and British are making desperate efforts on the west, in order to force the German commander to give all his attention to that front and to lessen or to abandon his attacks in the east. It is also quite evident that the Kaiser believes his western intrenchments can hold against any attempts the Allies can deliver, and that he is making a strong attempt by his advances on the Riga front to break down the morale of the Russian troops by a drive in the direction of Petrograd; it would be a far-away dream, however, to fancy that German generals would take the risk of a 300-mile advance on that city through northern Russia unless most excellent communications could be first established.

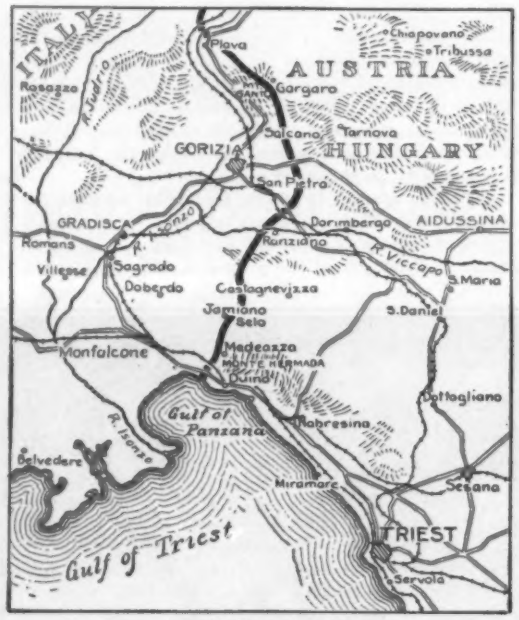
It has been known for some time that the Germans have been preparing for a strong offensive against the Russian armies and one which might extend along the entire eastern lines. This would be carrying out what has been claimed as Field Marshal von Hindenburg's view; viz., that, the war could be closed in Germany's favor by operations on the eastern rather than on the western front. Under existing conditions on the western lines, this view certainly seems exaggerated unless it be only to strengthen claims when peace is discussed. After the strong thrust forward by Marshal Haig, aided by the French troops on his left, which ended in an advance in front of Ypres extending from Bixschoote on the north in an arc through Lange Marck, St. Julien, Westhoek and across the Menin Road, only partial engagements have taken place along the lines here except that the Germans have taken some of the high ground south of the Menin Road that had been occupied by the British troops. Vigorous fighting has prevailed at many places here without definite results for either side.

South of this part of the line around Lens, most desperate encounters have taken place, the Germans resisting in every manner possible the steady crushing effects of the British offensive that is slowly but surely encircling the city. The advance through and over slag heaps, tunnels, passages and dug-outs has been particularly difficult; although no effort has been made to go forward into the heart of Lens—now but a heap of ruins—there seems to be no diminution in the strength of the British attacks despite the tremendous efforts already made. Practically they are now in the city and, before this article appears, the surrender or abandonment by the Teutons of this once great manufacturing center will doubtless have been announced. It would appear that what has been claimed as the new plan of fighting along this front is being begun with swift and unforseen assaults at a number of different points in the line. This has been shown by the fighting around Ypres and in Flanders, then it broke out at Lens, and now the French drive at Verdun has begun. By such widely separated attacks, the Allied commanders are trying to find a weak place in the German lines into which a wedge can be driven and also to put a strain upon the German reserves that are so rapidly dwindling.

Carrying out this policy that appears to have been finally adopted by the Allies, of attacking at points separated so that reinforcements on one part of the line cannot be quickly transferred to another, the scene has now been changed to Verdun, where that city dominates in interest the western front. Here again appear Hill 304, Dead Man's Hill, Bois des Corbeaux (Crow Hill) and so many other places on the left bank of the Meuse made famous by the first advance of the Germans in 1916 and where so many men have lain down their lives. But the tide has now turned and it is the French who are the assailants, it is to them too that the Germans are yielding ground—little at a time, it is true, but an advance nevertheless. After a three days' bomdardment that gave warning where the blow might fall, the French developed on August 20th an attack on both banks of the Meuse on an 11-mile front, penetrating the German lines almost at once to a depth of a mile and a half. The offensive extended from Avrocourt wood on the west to Bézonvaux. On the east bank of the river they took Talou Ridge in the bend of Meuse, Champneuville and one or more hills; on the west bank, success crowned their efforts by the capture of Dead Man's Hill, the village of Cumières and Corbeaux and Avrocourt wood. By the capture of the points in question, all direct observation of the town of Verdun itself has been entirely cut off.

Since the first attack and despite desperate resistance the French lines have gone forward for one or more miles until now Béthincourt and Forges wood on the west bank and Haumont and Caures wood on the east bank are once more in French hands. Thus, the last important strongholds won by the Germans last year have been retaken. Hill 304 and Dead Man's Hill control all the hills and ravines as far as Fort Douamont on the eastern bank and, therefore, all observations by the Germans of the French movements or concentrations of troops have been rendered impossible.

It will probably be premature to attach too much importance to the present operation in front of Verdun, for in scope it will not compare with what was done in October last when Fort Douamont was retaken almost without a blow or with the December qperations when Louvemont and Bézonvaux were quickly captured by an onrush of the French forces. This last onslaught has been a quick and decisive blow to dishearten and discourage the German forces, to take such local points as have been taken, and, by inspiring counter attacks, to inflict disproportionate losses in both men and material. However, the French have materially improved their positions for there are for the Germans, as stated, no points of observation on the city and therefore only long range guns can throw their projectiles into the town itself. How far the present move will be pushed will develop as time goes on; but it can be said that possibly no fortified place in history has ever exacted the number of human lives from the assailants and defenders that Verdun has



The Italian advance

in the past 18 months. It is believed that not less than one million men have been killed, wounded, or captured since the assaults upon Verdun began in February, 1916.

The battle of the Marne was the first failure of the efforts of the Hun in the conquest of continental Europe; the failure at Verdun marked the second step of the defeat of barbarism by civilization. In future, the name of Verdun will not mean a locality alone but an historical epoch.

The Italians began along the Isonzo River and also upon the Carso plateau on August 20th a double offensive and upon a greater scale than has ever before been tried by them upon either front. In artillery fire alone, the volume has been almost beyond belief, it having been stated that there has been a concentration of 9,000 guns on a front of 50 miles. Beginning near Anhovo some miles above Gorizia, the Italians crossed the Isonzo River at several points by pontoon bridges and immediately extended their lines to the east, breaking down the Austrian opposition along the Bainsizza plateau and in the valley of the Idria River that flows into the Isonzo from the southeast. From Plava north of Gorizia to the sea at Duino attacks were also begun over a 40-mile front to drive the enemy from Monte Santo on the north and to bring pressure upon the lines on the Carso plateau. The dent created in the Austrian front opposite Anhovo carried the Italian troops past Monte Santo and cut off the defending forces on that height. Thus, a position that probably never could have been taken by a frontal attack was outflanked and rendered untenable. The Austrian lines began to bend here and on August 25th, the Holy Mount, once a place of pilgrimage but now a strong fortress, was taken without difficulty. The capture of this position is of the greatest importance for, when the City of Gorizia was taken in 1916 by the Italians, but little in the way of military results could be obtained as Monte Santo towers 2,000 feet above it and the surrounding country. It effectually blocked the way to Trieste for no advance on the north nor in the south could be made without the danger of a flank attack from the mountain. Now, the country east of Groizia can be controlled by its capture and a thrust forward can be made up the valley of the Vippaco River between Monte Santo and the Carso plateau.

On this plateau counter attacks are being delivered by the Austrians against the Italian advances in the direction of Monte Hermada, which dominates the southern end of the Austrian defences nearest the sea. Undoubtedly some strong efforts will be made soon to storm or outflank this stronghold and thus open the gateway of the road to Trieste only a few miles away. It is probable that when the fighting in the north has taken to that vicinity the Austrian reserves, the Italian attack in full force will begin here. Last year their offensive was restricted by the need of artillery ammunition; now an unlimited supply both of guns and ammunition seems available; the Italian advantages in the present offensive can be credited to the use of guns, especially those of heavy caliber. If it is true, as reported, that the Italians are using such guns placed near the mouth of the Isonzo River that are reaching within two miles of Trieste, it is evident that the end must come soon as the Austrian lines are said to be already broken at several points.

Certainly, a decisive Italian victory at this time would have most important political results. Already it is stated that Austria is in a condition bordering on panic, and that Vienna has become so alarmed over the outlook that important changes in high commands have already been made. In fact, the fate of the Austrian Empire may depend upon the battles now raging.

The German advance in the Riga region has apparently ceased as but little has been said recently of events in the vicinity of the River Aa. This stream, along which the Russians have been maneuvering and behind which they are said to have withdrawn, flows north from Mitau on the western edges of the great Tirul marshes until it almost reaches the sea; then, turning due east, it runs through a sand spit between Lake Babit on the south and the Gulf of Riga on the north emptying into the Dwina River at its mouth. It thus encircles all the ground extending for miles to the west of Riga and forms a most wonderful natural line of defense. It is more than probable that, if Riga is to be threatened, it will be by flank attacks along the Dwina River. Farther south between Minsk and the Pinsk marshes, in the direction of Vladimir Volynski, and on into Moldavia, there has been intermittent fighting with varying results.

The thrust in the Italian theater of war has apparently halted operations on the eastern lines by rendering necessary the recall of Austrian divisions to the Isonzo front. Thus General Cadorna's brilliant attack may have important effects upon the Russian military situation as it now exists and may give time for that reorganisation that General Korniloff is so strenuously endeavoring to bring about.

Mosquitoes and Malaria

THE length of flight of mosquitoes is a subject concerning which information is desirable in connection with the control of malaria. The Public Health Service states that the ultimate goal should be to determine the distance of contaminating flight; it is possible that the maximum flight of the *Anopheles* mosquito is that which she makes to obtain her first blood meal, and she is not infective to man until ten to fourteen days later. This may explain why flights of extraordinary length recorded at Gatun in 1913 did not increase the malaria rate at that place. In the southern United States *Anopheles quadrimaculatus* is probably the principal carrier of malaria. Hence experiments have recently been made near North Augusta, S. C., on the flight of this species. Mosquito nets were placed close to the breeding places at night, and the mosquitoes were attracted into the nets by men who served as bait. They were then stained in the nets by spraying with a one per cent solution of eosin, and liberated. Resting Anopheles were also caught in the daytime in heavily infested houses. All the insects were taken to a point in the breeding area selected as a liberation station, where they were stained and liberated. The general results were that the maximum flight from a profusely producing breeding place was one mile, while from places producing less abundantly the flight did not exceed half a mile. Mosquitoes captured in houses return to the locality where collected.

The Hair-Spring of the War

How the Council of National Defense Keeps the Wheels Running Smoothly

By C. H. Claudy

A WATCH needs two springs to make it go. Motive power comes from the mainspring, which stores the power of the fingers that wind it. Balance and even running come from the hair-spring, without which the mainspring cannot function.

The main spring of the war machine, call it the President, the people, the Congress, the War Department, what you will, has plenty of power. But, like the watch spring, it cannot work alone. Its energy must be properly supervised, its powers coördinated, its thrust directed. To a large extent, at least, these are the functions of the Council of National Defense—supervision, coördination, direction, suggestion, particularly effective in securing for the governmental mainspring the winding power and irresistible torque of private business.

It is difficult to make an adequate statement of the work of the Council because so much of its most valuable work is accomplished through its function of adjustment. The definite results of the Aircraft Production Board, in expediting the construction of an air fleet, or the saving effected by the Committee on Supplies in securing prices on government clothing below that paid by the private wholesaler, are accomplishments easy to make clear. The results of a conference are less visible if no less concrete if they smooth out kinks in the war machine of the whole governmental and industrial system. Much work of the Council and the Advisory Commission has been of this character, its whole value known only to those immediately in touch with it.

During the past two months the General Munitions Board assisted the Quartermaster's Corps, through the Emergency Construction Committee, in building the new army cantonments. By bringing into consultation experts in every kind of work involved, the committee has made available to Colonel Isaac Littell, in charge of the work, the latest professional information on city construction, from the nation's most successful architects, sanitary engineers and city planners, an excellent example of the Council's function as a connecting link between government and industry.

In securing munitions the General Munitions Board, whose functions the new War Industries Board has taken over, has developed many new supplies for gun forgings and the manufacture of artillery, greatly increasing the production of field and machine guns in quantity at a much earlier date than was anticipated. This work has been done largely through conferences with manufacturers, subordinating commercial demands to government needs.

All kinds of supplies come under its jurisdiction; carriages, limbers, caissons, forge wagons, military vehicles, steel helmets, surgical supplies, optical glass gages, tools and dies. Questions as to price, priority of shipment and methods of expediting production are referred by the Departments to the Board, which serves as a general clearing house for innumerable problems coming from departments and committees on munitions, raw materials and supplies.

Railroad work, directed through Chairman Willard of the Advisory Commission and the war executive committee of railroad presidents, has accomplished much. To quote Mr. Willard, the roads "have made all transfers of troops on schedule without serious disruption of regular traffic." In spite of shortage of freight cars and terminal facilities, the supply of coal cars has been greatly increased and freight traffic expedited. The largest regular traffic in history has been constantly increasing yet the shortage of cars was reduced from 148,627 on May 1st to 105,000 on June 30th.

The Telephone and Telegraph Committee has put the communication lines of the country at the government's service. Every town can be reached almost instantly any time with messages from authorities at Washington, not only army and navy orders, but requirements of almost equal importance in modern warfare—the mobilization of agricultural, industrial and commercial resources.

Thousands of new switchboards and miles of new wire are being installed. The new army cantonments are fully equipped with telephone and telegraph facilities, both national and local. Battalions of experts organized for field work, and engineers of the telephone companies are working with the army and navy on improved communication devices.

The Aircraft Production Board program for a great extension of the military air service was developed in coöperation with the Signal Corps and navy airplane experts. The program, under the $640,000,000 bill passed in record time by Congress, has been worked out in great detail, including personnel, standardization of machines for quantity production, equipment, machine guns and scientific apparatus.

Three of a system of 24 training fields have been completed, training machines are now being shipped and instruction in flying begun under reciprocal arrangements for training American cadets in Canada in return for training Canadians in the South in the winter. Ground schools established in American universities supply cadets, and within a few months a stream of aviators will flow to France. Unusual work has been accomplished in American aircraft engines for fighting and bombing machines, while several firms are turning out European models. A mission of technical experts has been in Europe for weeks gathering information for American manufacturers.

The Committee on Raw Materials, Mr. Bernard Baruch, Chairman, has listed sources of supply, developed new sources, and through the assistance of producers, placed at the disposal of the departments the materials needed in quantities and at reasonable prices.

Many rare materials, particularly chemicals needed in the manufacture of explosives, have been secured in quantity—indeed, the Committee on Raw Materials has mobilized the whole range of raw products needed for war uses, ascertained the amounts available and developed all possible sources from which to draw them. Through personal conferences, speed in delivery and prices impossible under normal conditions have been obtained for steel, sheet steel, ferro alloys, pig tin, tin plate, scrap iron and steel, wire products, wire rope, tubular products, cold rolled and cold drawn steel, copper, aluminum, brass, rubber, cement, alcohol, asbestos, magnesia and roofing, coal-tar by-products, lead, mica, nickel, oil, pig iron, iron ore and lake transportation, sulfur, wool and zinc.

The Committee on Lumber supplying the war needs of the government has been of especial importance in the building of the cantonments. Lumber for cantonments, aviation fields, shipping, naval stations, storage warehouses, and innumerable other projects has been secured in the requisite quantities at prices below the wholesale market rate.

The Medical Section has secured physicians of proper caliber for War, Navy and Red Cross medical service and focussed on the great health problems the combined skill of national leaders of the profession. Though the constant efforts to supplement the work of the Surgeon General's office in securing applicants for the Medical Officers Reserve Corps have not yet solved the problem, the Section has secured many properly trained men. Committees of the General Medical Board have tested drugs and medical supplies and standardized and stimulated production, relieving a serious shortage.

Particular attention has been given preparations for sanitation in cantonments. Through the medical sections of the state councils the Section has focussed the attention of local health authorities on the problem of safeguarding health conditions around the new camps, and in the neighborhood of munitions factories. Finally, frequent consultations with deans of medical schools have been held on methods to prevent medical students leaving their work to join military forces with the consequent disorganization of the profession.

The Commercial Economy Board has been concentrating on campaigns to eliminate the return of unsold "stale" bread, to assist in conserving the wheat supply, and to cut down the waste in the over-developed delivery systems of grocery, department and dry-goods stores. Conferences have been held with manufacturers on simplifying styles of shoes and clothing to eliminate waste of material and labor, a work based on searching study of European experience and local conditions.

The release of thousands of men and the conservation of much capital has been secured through publicity through the press, the state councils of defense, and conferences with representatives of business affected.

The Committee on Supplies, Mr. Julius Rosenwald, chairman, has aided in securing supplies in quantities at prices appreciably below the market. Working through personal conference with manufacturers and producers huge orders have been procured without the stimulation of the market which open bidding usually brings. As a result the public has not suffered by a large rise in prices. In negotiating for shoes, for example, the coöperative committee on leather secured an option on leather required at normal prices, making it possible for manufacturers to bid without paying exorbitant prices for raw materials. Whether the product was shoes, clothing, saddlery or food stuffs, the committee has gone direct to both manufacturer and producer of raw materials, thus avoiding the usual price manipulation which attends bidding for government contracts.

Many new sources of supply had to be opened, however. The highly specialized nature of the government's needs had in peace times confined the manufacture of many kinds of equipment to a very limited number of firms. The Committee has done most valuable work in advising the government on the revision of requirements to meet commercial conditions, as well as the adaptation of existing plants to the manufacture of government supplies. As an example, the existing facilities for the manufacture of duck at the beginning of the war were entirely inadequate for the government's needs. Through the committee's efforts specifications were modified and the looms of a number of carpet manufacturers adapted successfully to the work, with the result that 500,000 men can sleep in tents this fall. The work has extended over a wide range including uniforms, shoes, saddlery, wool and cotton clothing, meats, canned goods, food stuffs, beds and bedding, towels and tentage.

The Committee on Coal Production has stimulated production of an adequate supply of coal for the navy and army, the civil population, and to some extent the Allies. It has brought about a pooling arrangement for the Atlantic tidewater region to eliminate the waste in car and barges service under the old system of individual consignments. A similar arrangement for the Great Lakes Northwest has successfully operated for many weeks.

Mr. Gompers's Committee on Labor, carrying out the resolution providing for maintenance of existing standards, has relieved labor unrest and settled strikes, while preventing abolition of existing safeguards of the health and welfare of workers. The importance of its accomplishments is not minimized because effected indirectly. A large body of representatives of both organized labor and business executives are constantly engaged in Washington making plans for the care of munition and industrial workers, considering mediation and conciliation, wages and hours, women in industry, industrial safety, sanitation, vocational education, recreation, and public education in health.

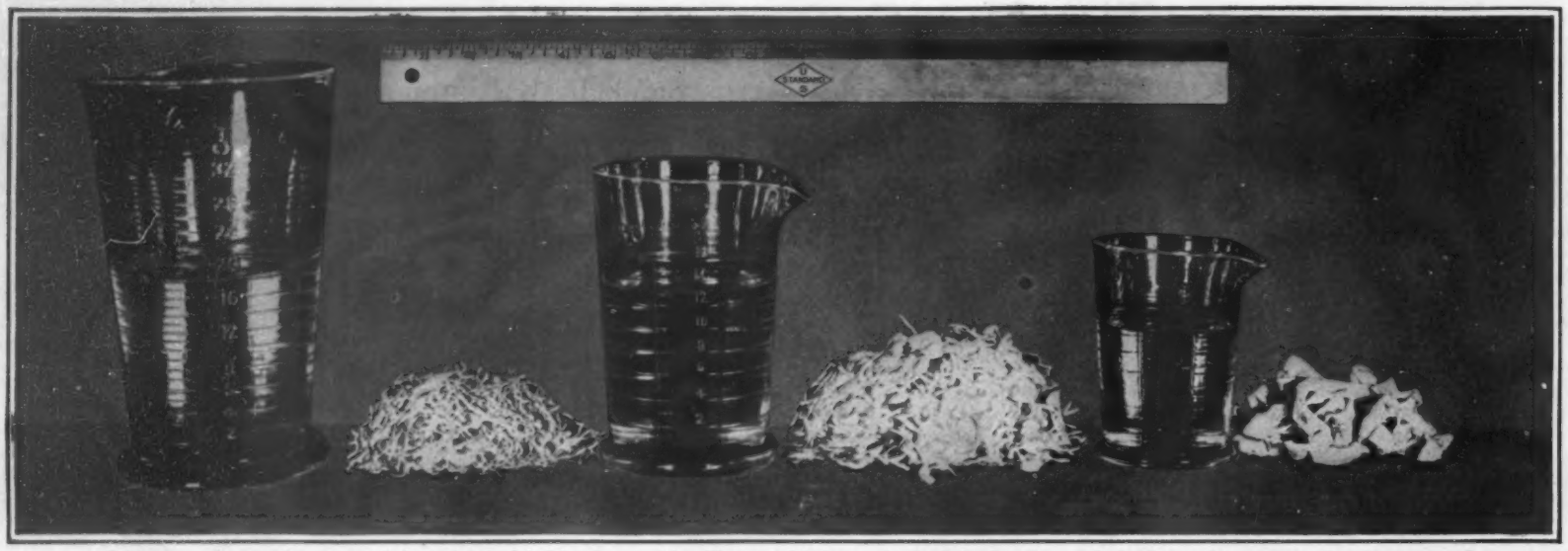
Dr. Godfrey's Committee on Engineering and Education has investigated the relations of educational institutions to the war, the adapting of courses to the national needs both now and in the reconstruction period to follow the war. Recently a group of distinguished Canadian educators came to Washington for a two-day conference to give American institutions the benefit of their experience during the war.

The Women's Committee has secured the coöperation of the women in the most effective forms of war service. Through a country-wide organization of local committees, aided by national registration, women have been informed of ways in which they can best help. Particular assistance is rendered the food administration and the Commercial Economy Board in getting women behind these movements. The committee has assumed the function of a war advisory board to America's women.

The Coöperative Committee on Automotive Transport has adjusted industrial conditions to produce all the needed motor trucks, tractors, airplane engines, motor boats and other forms of machinery driven by internal combustion engines, and has brought to the government the fruit of the standardization which has made quantity production of motor cars one of America's marvels.

To sum up the work in a paragraph, the organization has accomplished the adaptation of the nation's railway facilities for war purposes; the development of sources of supply for war munitions and component parts, from artillery and machine guns to various forms of motor transport; unusual progress on a comprehensive aviation program; material assistance to the War Department in the construction of the new army cantonments; the adaptation and augmentation of electric communication lines; the procuring of leather and textiles and supplies of all kinds for the armies; the coöperative development of lumber, copper, aluminum, steel and other raw material sources for the war needs of the government; notable progress on many phases of the difficult labor problem; extensive assistance in the consummation of the medical preparations for the care of the military forces of the country; and definite accomplishments in the adjustment of commercial conditions and methods to war needs.

The above is but a condensed outline of the work which the hair-spring is doing for the mainspring—to catalog all its activities would be to show it more as "the whole works" than as a balance wheel without motive power. Yet it should be a point of pride to every American that the Council of Defense and Advisory Committee, especially the latter, serving without pay and from patriotic motives alone, without authority save that of truth and facts, has so large a list of accomplishments at which to point.



Cabbage, onions and potatoes (left to right), dried by the machine illustrated below. At the left of each sample is shown the amount of water removed

Ninety Per Cent of Water

What Its Elimination by Dehydration Means to the Farmer and the Housewife

THE b[illegible] of civilization is that of a never-ceasing [illegible] winter. Under each of the three headings into which the necessities of life fall, man's difficulty has been that the favorable season is followed by an unfavorable one. Always he had to store up food, prepare clothing, and build a shelter against the day when nature's productivity is suspended and her erstwhile smiling face begins to show a frown.

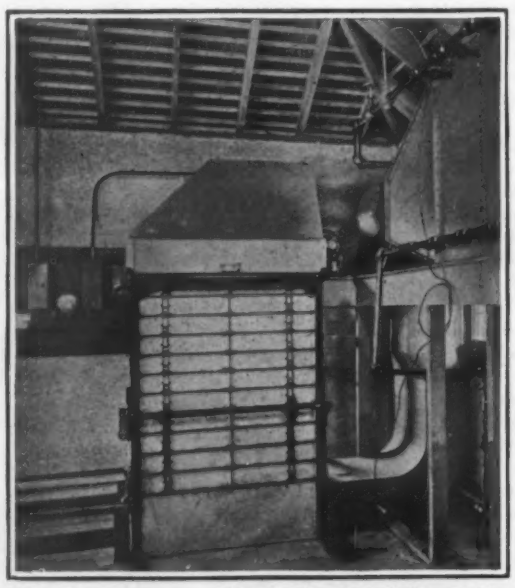
The great problem of food storage arises from the fact that in its normal condition food, with few exceptions, will not "keep." We know, as our remote ancestors did not, that the difficulty is that of excluding the bacteria whose presence causes change. But even though lacking this specific point of attack, from time immemorial men have known that heat, cold, salt, exclusion of air, removal of water, would all aid in the effort to keep the stored supply of food in edible condition.

With the enormous increase in size and number of cities during the past century, the problem of winter sustenance has assumed tremendous proportions. It has been met by elevating to the place of first importance a method of food preservation that had always been of least value—exclusion of air. The tin can and the sealed glass jar are the inventions which made this possible, and without them modern city life, if not actually out of the question, would have been vastly more difficult. If the reader will but try to conceive what his mid-winter menu would be like stripped of all the articles that come to him in glass or tin, he will hardly question any estimate which we may feel inclined to make as to their importance in the civilization of today.

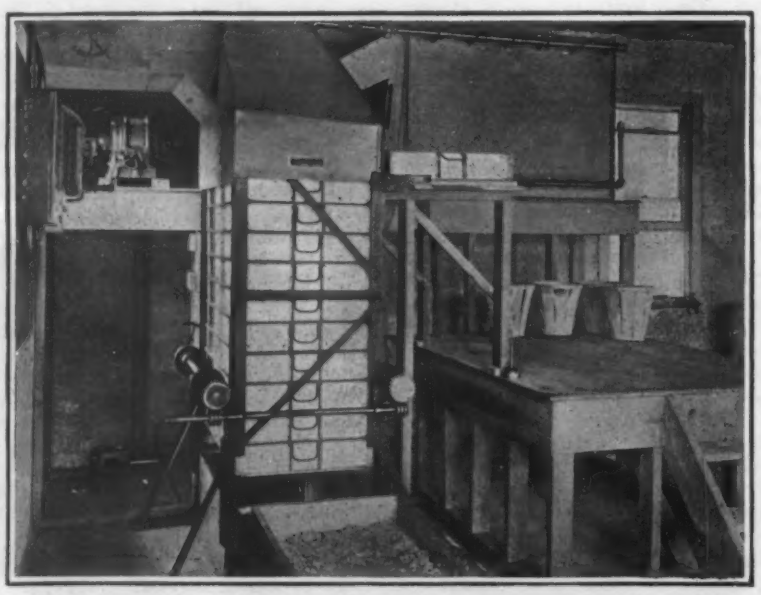
With all due allowance for their undoubted benefits, however, the tin can and the glass jar have not shown themselves altogether free from reproach. They must shoulder full responsibility for the growth of the factory system of food production, which at its best falls short of being an unqualified boon to the consumer. Then, too, neither is an ideal receptacle for food. Yet, if food is to be so treated that the container must be water-tight, there seems no substitute. Accordingly the alternative is presented of putting up with the tin can and the glass jar, with all the defects which we perceive them to have, or of making a change in our methods of food preparation which, if the skill of our cooks be sufficient to prevent the concrete results from marking a revolution when they come on the table, will inevitably mark a revolution in the factory and the kitchen.

The conditions arising from the war have operated to make this alternative much more critical than it would otherwise have been. And the weight of expert opinion is emphatically that we are about to decide in favor of a revolution, that we are about to institute a change in our mechanism of food supply more fundamental in its nature and more far reaching in its results than anything since the invention of the tin can itself. We are going to discard the whole elaborate system of preserving our food in condition to eat; instead of wetting it down and cooking it before preservation, we are going to dry it out thoroughly and in all but a few cases preserve it raw. Dehydration is the word; and unless a very large array of food experts—in governmental, commercial and educational circles alike, and among the mere consumers too—are barking up the wrong tree, it represents a process that has come to stay.

Several systems have been put forward, here and abroad, for preserving food by removing the water. To realize what this means, we must reflect that raw onions are 87 per cent water, celery 94 per cent, potatoes 78 per cent, string beans 89 per cent, ripe fruits from 75 to 90 per cent. Dehydration, however, it is to be emphasized, does not mean desiccation, does not involve the removal of every vestige of water, until the residue is truly dry in the chemical sense. Such treatment would destroy the typical structure of the vegetable, so that, upon wetting and cooking, dried onions might, to be sure, taste like onions, but would look neither like onions nor like anything else. Dehydration contemplates that from five to ten per cent of the water originally present be allowed to remain. This is enough to maintain the characteristic structure, so that after wetting and cooking any dried vegetable looks and tastes exactly as it should look and taste, and yet not enough to form a basis for bacterial growth. When damp air is excluded, dehydrated vegetables will keep good indefinitely.



Side view of the new dehydrator, with loading table moved away, showing the thermo-static control on the duct which carries the hot dry air to the trays



Front view as a finished tray is removed. A few turns of the crank lower the others, and the tray waiting its turn at the upper right is then slid over

The advantages of dehydration have been much dwelt upon, in these pages and elsewhere; nevertheless we must sum them up here, if only for the purpose of determining what sort of dehydration offers greatest advantages. A very general impression has gone about that this is a game which the ultimate consumer can play with profit; and baby outfits are obtainable for the purpose of home dehydration. To the extent that the housewife is thus enabled to visit the markets, buy overstocks of vegetables in quantity at a bargain, and dry them for future use, this is of course practical. But the housewife will hardly find it a financial economy to dry vegetables at the current market quotations, now or at any other time; and it would seem that a very poor way to remedy the producer's and the marketman's loss is to turn it over to the consumer as a profit. We should aim to prevent, not merely to balance, this loss. Accordingly, too strong emphasis cannot be put upon the fact that the place for the dehydrator is on the farm.

The ideal system would have the producer shipping each day to his market just so much of each article as can be disposed of there at a fair price. The balance of his day's crop he would feed to the dehydrator. This balance would include not only the stocks which under present conditions go bad while standing unsold in the markets, or which break the price to a figure at which the farmer makes no profit, but also all that rots unpicked on the ground, all that is picked and thrown out as not worth shipping. As a fair sample of what the latter items include, we would mention the green outer leaves which must be stripped from celery before it is in market condition, and which come close to equalling in bulk the parts which can be sold. These leaves are at present a total waste; yet for soups and flavoring purposes they are equal to any celery hearts that ever grew. Also countless tons of beet-tops which would make excellent greens are wasted for want of a good means of marketing; and no man can estimate the under-size and over-ripe fruits and vegetables which are picked and never sent to market. All this can be saved.

Under the system outlined, the dehydrator is as much a part of the farm equipment as the churn or the plow. The day's run is as much a part of the farm routine as the milking. The storage and winter shipment of dehydrated vegetables is as much a part of the farm's winter business as is the storage of hay and fodder and its

feeding to the stock during the cold months. The advantages of all this are vast. In the first place, millions of dollars worth of transportation which is now wasted would be saved. The amount of water which, in the guise of fresh fruit and vegetables, is annually shipped from one part of the country to another, is staggering. On such of our crop as must always be shipped fresh to meet the day's demand for fresh green goods, this is not to be avoided. On the thousands of tons that are shipped from grower to canner, canned with great addition of water, and then shipped back and forth between canner, storage house, jobber, retailer and consumer, it represents a wholly needless waste of car space and power. Dehydration does away

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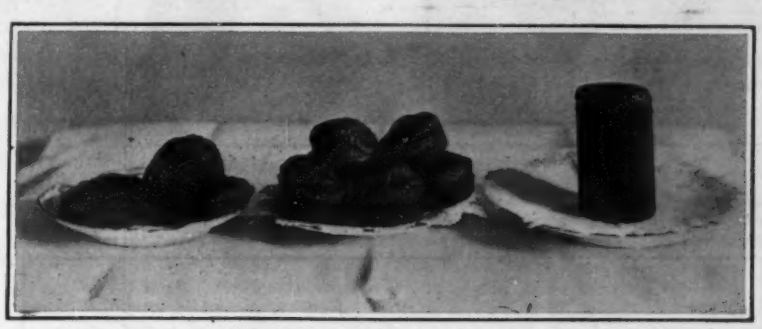
Making Food From Fodder

By O. R. Geyer

FEAR of a possible world-wide shortage of food which may bring the pinch of hunger even to Americans has sent many scientists and food chemists into their laboratories in an effort to relieve the food situation in so far as science can accomplish that end. As a result huge quantities of products which have been used for other purposes than the preparation of foodstuffs are being added to America's war menu. These articles can be used to supplement such staple products as wheat, corn and other cereals, since chemists have discovered that their food value is hardly less than that of corn or wheat. It simply remains a question as to whether the American public cares to adapt itself to these new conditions, and this may become a necessity in case the worst fears of food experts are realized.



Appetizing brown bread and muffins made from feterita and kafir corn

Among the most interesting of the long series of experiments which have been under way in recent years or are in progress at this time are those of Oklahoma Agricultural College, which have added a number of important food products to the country's food supply. Chief among these have been cotton-seed meal, and flours made from kafir corn, feterita, grain sorghums, milo and kindred grains, all of which have heretofore been used mainly in the feeding of livestock. Bread and other articles of food made from these cereals not only are palatable but have a high food value. The most important feature, however, is the fact that they are already produced in notable quantities.

The discovery of flour substitutes has been the most important problem since the worldwide shortage of wheat has brought about an actual shortage of food supplies. Three southern and southwestern states, Oklahoma, Kansas and Texas, however, can supply enough kafir corn and cotton seed flour to make up the country's flour shortage this year, and by next year, should abnormal conditions demand it, enormous quantities of these flour substitutes can be produced in almost all of the farming states, but more especially in the southern states where the wheat crop is a small item in the crop production. Two years ago Oklahoma alone produced 30,000,000 bushels of grain sorghums, the grains of which can be converted into flour, and this year will see a crop even larger. This is about four times the state's wheat production and, of course, will be an important contribution to the nation's food supply.

The adaptability of the grain sorghums, kafir corn, feterita, a comparatively new American grain, milo, and similar grains to southern soil and climatic conditions will enable the southern states to produce enormous quantities of these substitutes for wheat, and will result in their becoming enrolled among the great food producing states of the nation. The cotton crop grown by the south already yields great quantities of material which can be converted into acceptable foodstuffs. Until recently cotton seed, despite the fact that it contains more protein than almost any other food product grown in the country, has been used almost exclusively in the preparation of certain cooking materials and for feeding livestock. In fact, the percentage of protein in cotton seed is so high that care must be exercised in adapting it for food purposes, both for animals and human beings. If food products derived from cotton seed are prepared under the direction of experts, however, there is absolutely no danger, and an enormous quantity of foodstuffs will be added to the nation's supply.

Cotton-seed meal serves its best purpose when mixed with kafir corn, which is also expected to serve an important end in replenishing the country's larder in the coming months. Commercial cotton-seed meal can be used in the preparation of food products which contain 51 per cent of protein and, if used intelligently, can be made to replace meat in an ordinary diet as a source of protein. As sold on the market cotton-seed meal will contain from 30 to 48 per cent of protein. Compared with the percentage of protein found in other common food products, the balance in favor of cotton-seed meal is most one-sided. Protein in round steak will range from 12 to 16 per cent, in beans about 20 per cent, peanuts, 25 per cent and in wheat bread about 9 per cent. The muscle-building properties available in food products prepared with cotton-seed meal are apparent at a glance, for they average from three to five times the quantity found in wheat flour.

Germany has been compelled to resort to the use of potato bread as a substitute for wheat, which is hardly in the same class with cotton-seed meal and kafir corn flour. As a war food, this latter combination is "fit for the gods," in the opinion of food chemists who have been conducting experiments of this character since the war began. More enthusiastic friends of this new flour substitute declare that in time America would not be willing to abandon this new food. Certainly, at least, it has been found most palatable by those who have tried it. A recent gathering of Oklahoma editors was served with bread made from a combination of feterita flour and cotton-seed meal, which was found to be much more nutritious than bread made from wheat flour.

There is almost no limit to the number of ways in which flours made from feterita and kafir corn can be used. As a breakfast food, they are as palatable and attractive as any of the varieties now being served on the tables of the American people. Delicious muffins, brown bread, cookies and griddle cakes have been prepared from feterita and kafir corn in the Oklahoma laboratory, and in all of these foods it has been found possible to utilize cotton-seed meal, thus increasing the percentage of protein. Homes in which foods prepared with these flour substitutes have been used have found them more valuable and attractive to the taste than foods prepared with wheat flour, which gives assurance that this new form of "war bread" may become widely popular in America.

Any widespread adoption of "war breads" made from these products will not withdraw large quantities of foods from animals, for the stalks of all grains can still be used for silage and make a valuable food for live stock. Utilization of the grains for human food, is, of course a thrift movement of national importance. The sorghum grains, of which there are many varieties, have been found to be acceptable substitutes for corn products. The grain sorghums, and kafir, milo, feterita and similar grains, while permanent crops in many southern states, notably in the southwest, have not been planted as extensively as they might be. In Oklahoma alone the annual crop of these products could be increased four times without much trouble, while vast acreages of Texas lands are available for these crops, which have the value of being drouth resisters to an important extent. It is estimated that Texas alone could produce enough of these cereals to supply the entire nation with "war bread." Combining this available addition to the food supply with the huge quantities of cotton-seed meal which can be produced without increasing the acreage devoted to that crop, America can well withstand any seige which famine may lay at her doors. An important factor that will lend encouragement to the utilization of

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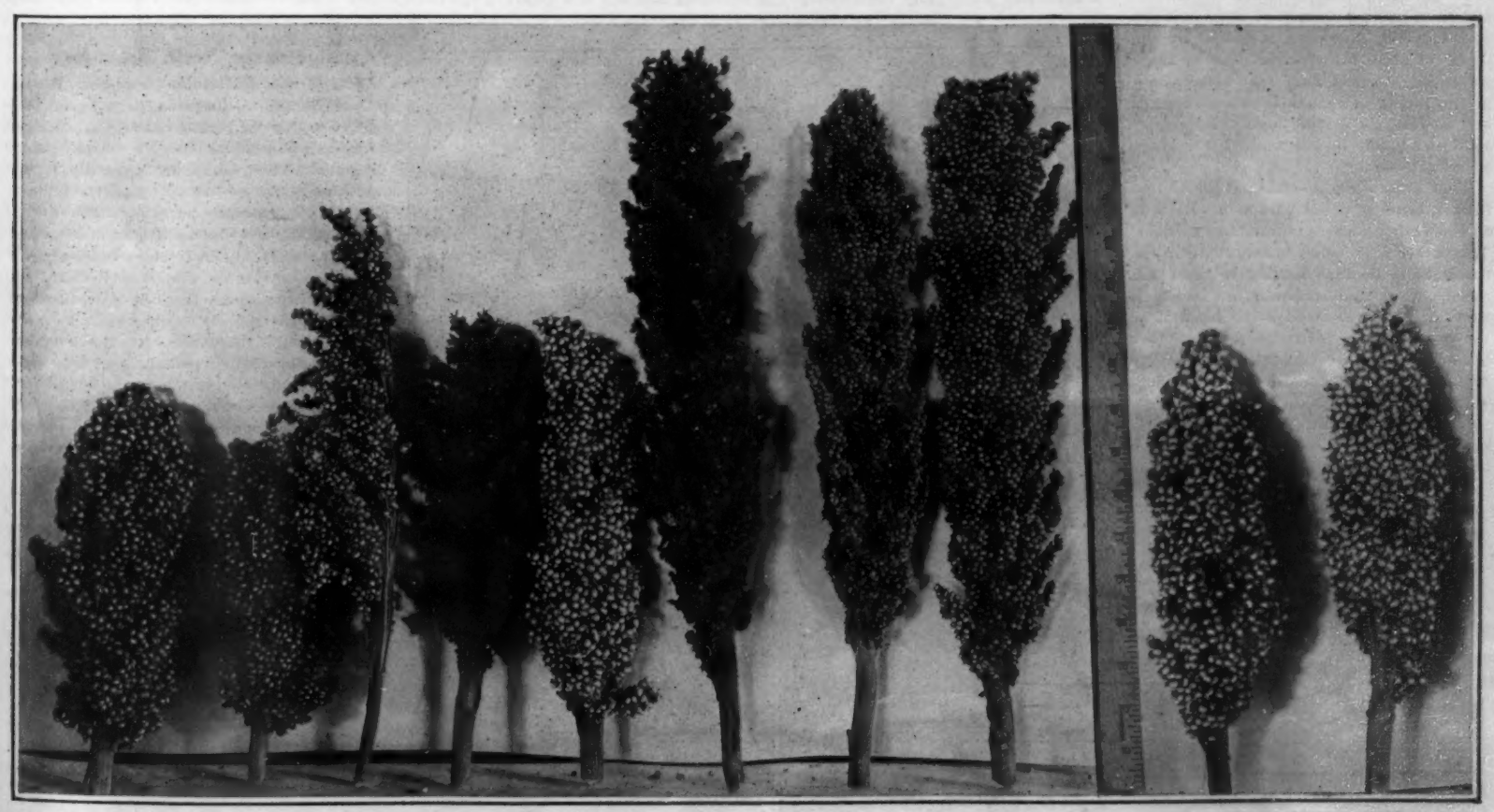

A number of grains now being turned to account as food for man. From left to right these heads are yellow and white milo, sorghum, brown and white kaoliang or Indian millet, red, pink, and white kafir corn, and two varieties of feterita

Scientific Headlight Control

By M. F. Deming, Sponsor for New York's New Headlight Law

ON August 1st there went into effect in New York State, an automobile headlight law based on a new principle. If this were generally understood, it would be universally adopted, putting an end not only to the headlight problem, but to the conflicting laws and regulations relative to dazzling headlights which have become one of the outstanding annoyances of motoring.

This is not an anti-glare law; the word glare does not occur in the text of the measure. Good strong lights are mandatory, and an automobilist is as liable to arrest for having poor lights as for having improper ones. But if all cars were equipped according to the principle embodied in this law, accidents attributable to headlights would be as uncommon as cases of smallpox. Therefore all automobilists should become familiar with the idea behind this law and use their influence to have it adopted in their own communities.

When light from an automobile headlight falls upon an object ahead, some of it is reflected back to the driver's eyes. Under favorable conditions this reflected beam may be one-tenth as strong as the direct light from the headlights to the object. Generally it is not more than one twentieth as strong; yet the driver can see by it with ease. But upon meeting another car, a light 10 or 20 or even 50 times as strong as that by which the driver has been seeing strikes full into his eyes. The pupils contract, just as in passing from a dark room to a brightly lighted one, and nothing can be seen. After the automobile has passed, the effect is reversed, and becomes analogous with that produced in going from a bright room to a dark one. Every time another car is passed at night two adaptations of the eyes have to be made. This requires about five seconds—a period during which nothing can be seen by light reflected from the road.

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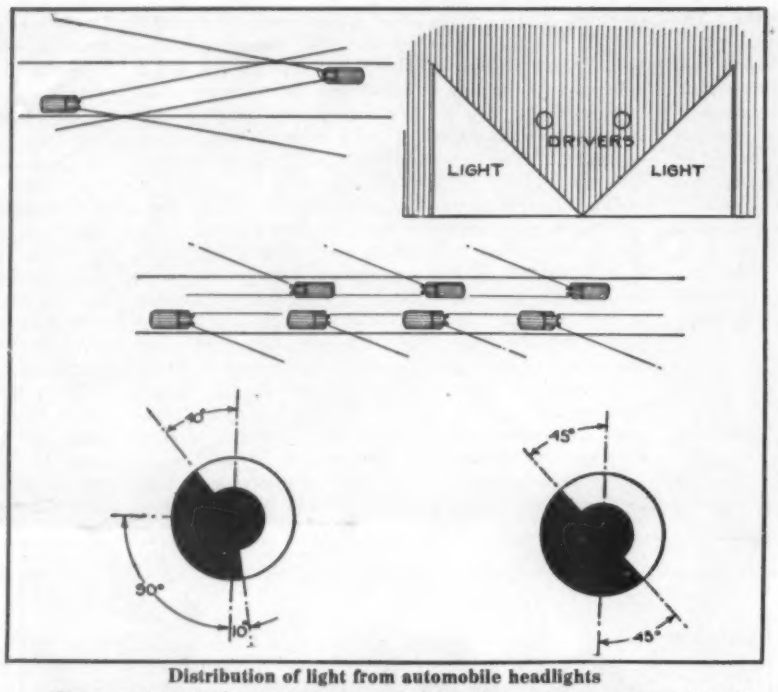
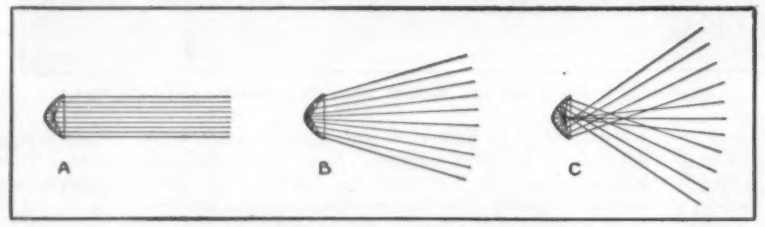


Distribution of light from automobile headlights

The wrong (upper left) and the right (center) distribution of light over the roadway by approaching automobiles; a vertical section of the road through two passing cars with the correct lighting (upper right); two ways, seen head on, of painting the headlight bulb to secure the desired effect (below), the first being recommended for city use, the second for the country.



Three ways to focus the headlight

Each of these can be secured with any reflector by moving the bulb a little backward or forward. The parallel and the divergent pencils are not good; the fan shaped bundle of rays at the right is the best way, and has been assumed in the above diagrams showing bulb screening.

The Serpentine Grade Crossing

THERE is one aspect of the grade crossing removal problem which has not received the consideration which it merits, and which is admirably illustrated by the cuts herewith. We refer to the treatment of the serpentine crossing.

Every rider in the railroad trains must have observed on countless occasions the trick which rural roads have of snuggling up close alongside the tracks for a distance and then turning sharply to cross at right angles. This, of course, is caused by the desire to make the crossing itself as short as possible, so that there may be economy in the laying of planks between the rails and so that, in driving across, a "team" shall be actually on the tracks for as short a time as possible.

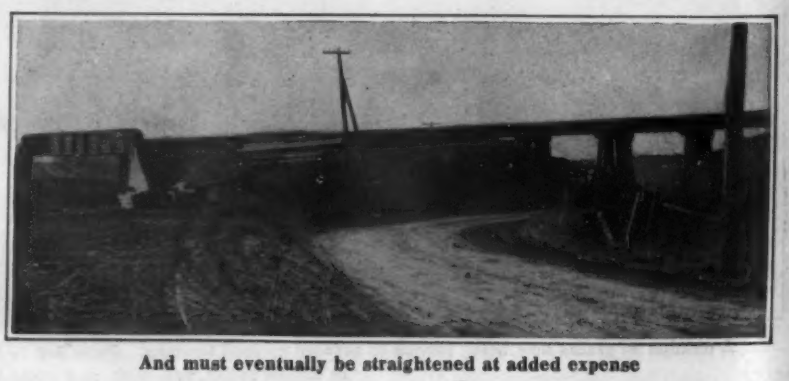
That even when operated at grade this type of crossing is not without its dangers to the swiftly moving automobile is clear. The driver may come unexpectedly upon the right angle turn leading to the track along which a train is passing, and be forced to ditch his car to avoid worse disaster, or the presence of a telegraph pole or other hazard at a critical point may lead to accidents like the one we illustrate, and which actually cost a life.

But it is with conversion into an underneath or overhead crossing that this type of road-building displays its devilish character to perfection. We show a road which, when it crossed the rails at grade, turned from its course and went through one of these double contortions in order to cross at right angles. With extraordinary but by no means unusual stupidity, the course of the road was left unaltered when it was depressed to go under the tracks. Nobody who has ridden in an automobile will need to have the extraordinary risks of that crossing pointed out to him. In fact, the list of head-on collisions under the bridge became such a long one that it was absolutely necessary to do what should have been done in the first place—connect the two straight segments of the road by means of a long diagonal crossing in the same line. The most casual inspection of our cut will convince anyone of the extent to which this road was improved by the change.

That the kink type of crossing is no better when it goes over than when it goes under, is made plain by our second cut, which contains enough suggestion of disaster to frighten a timorous autoist into giving his car away to his dearest enemy. All in all, we believe that few collections of photographs make their point so well as this one.

Even at grade the serpentine crossing is dangerous

When it goes above or below the tracks it is far worse



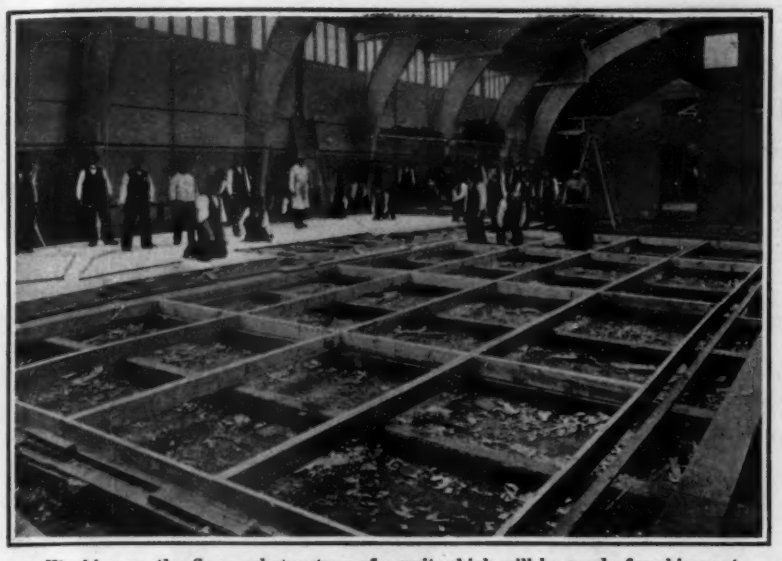
And must eventually be straightened at added expense

The Current Supplement

THE electron is usually regarded as merely a figure of purely scientific theory in chemistry and physics, but that it is of practical and technical importance is shown in an article on *Industrial Applications of Electrons* in the current issue of the SCIENTIFIC AMERICAN SUPPLEMENT, No. 2175, for September 8th. *Cultivating Wild Flowers* tells in a very pleasing way of many beautiful plants and flowers that might be introduced into our gardens with admirable effect, and gives brief instructions on their planting and care. *A Buffalo Bull Fight* gives a realistic description of an incident in one of our National Forest Preserves, that throws light on some of the habits of these animals. There are pictures of the victor and his family. *The Metric System* gives a very lucid explanation of the system, together with examples of practical applications in technical problems that clearly demonstrate its incontestable advantages. Two diagrams accompany the text. *Observation Balloons and Artillery Fire* gives a brief account of the services this form of aerial craft performs in the war. There is a striking picture illustrating the work. *Osmotic Pressure* summarizes some papers on an important problem in physics and chemistry that were recently presented before the Faraday Society. *Reducing Drug Plant Cultivation to a Science* calls attention to the desirability of developing an important new industry. It is illustrated by an excellent photograph. *Some Insect Pests* illustrates by four unusual photographs a few of the menaces to trees and agriculture with which we have to contend. *Concrete Structures in War* reviews the uses that have been made of this valuable building material for military purposes. *Unsinkable Ships* calls attention to the necessity for stability in the design, a feature that has been generally overlooked. *Cytology* is the title of a paper of unusual interest to every student of physiology, as it examines various methods of investigating living cells, and points out methods for making accurate studies. It is illustrated by a number of special cuts. *Fluorescence and Phosphorescence* deals with their use to produce luminous effects.

Aviation in the North Polar Regions

THE veteran polar explorer Roald Admundsen declared in a recent interview that he considered the conditions for aviation ideal in the north polar regions. The winds are generally light, and hence the cold is not so severely felt as people generally suppose. Above all, the atmosphere is stable and homogeneous; there are no "holes in the air." The atmosphere is remarkably clear, so that aviation offers the best facilities for mapping the regions in question. In connection with these remarks, the average citizen cannot help feeling a certain impatience over the fact that, although for the past ten years we have been hearing encomiums upon the aeroplane as an ideal agency in exploration, so very little use has thus far been made of it for this purpose.



Working on the floor substructure of a unit which will be ready for shipment before night

Building houses indoors—standard knock-down hospital barracks in different stages of construction near Hamburg

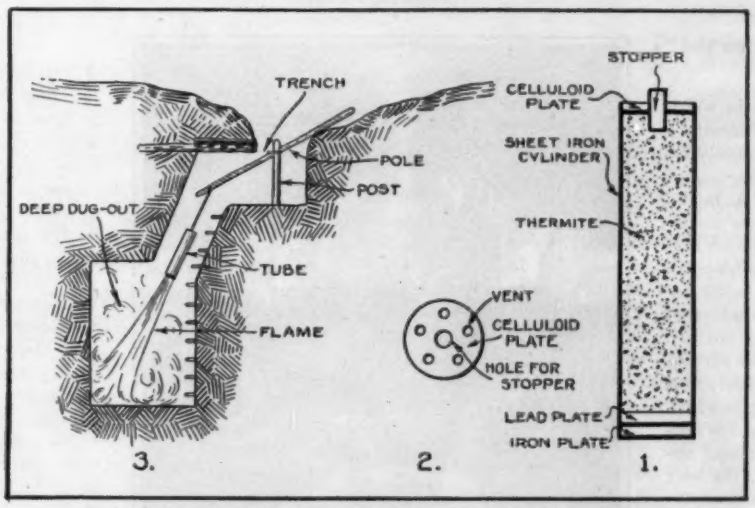
Standard Hospital Barracks

How Germany Manufactures These in Large Numbers

THE world war takes hold of practically the whole field of engineering activities. Thousands of normally peaceful shops are now engaged, night and day, in ceaselessly manufacturing weapons and ammunition and supplying the rest of the enormous war material required by millions of soldiers. Among other demands, thousands and thousands of wounded have to be accommodated, and since the masons at hand cannot always keep pace with the requirements, the hospital buildings used in this connection are manufactured partly of wood, on a wholesale scale and by the most approved factory methods. In addition to perfect preparedness, this insures the advantage of obtaining hospitals that are entirely transportable.

In the immediate vicinity of Hamburg, where the immense shipbuilding yards of the German commercial steamship companies are to be found, are the shops where day after day, an endless series of hospital barracks is turned out. As seen from the accompanying pictures, the rules of shipbuilding are carried out here, too, an ingenious division of labor making it possible to complete by nightfall the barracks begun in the morning. This can only be accomplished by working simultaneously at different elevations, with huge up-to-date planing and sawing machines operated by a few hands. As soon as the barracks floor is completed, the walls and roof, manufactured in another department, are added. Everything pertaining to the complete equipment of the finished barracks is turned out on the premises, in the smithy and the multitude of other shops. Even the window curtains, the stoves, the chandeliers and the medical outfit are made here and added to the ensemble before shipment.

The following particulars of design may be of interest. The barracks are of standard dimensions, 15 meters in length and 5 in width, with walls 2½ meters high and a ridgepole 3.65 meters from the ground. They are built to accommodate 18 beds, and their total weight is about 8,800 pounds. Each barracks comprises a carefully jointed wooden floor, the substructure of which knocks down into coffin-shaped boxes in which the wall and roof panels are packed up during transport. The wall panels are coupled together into pairs by means of hinges. Each gable wall, as well as one or two of the longitudinal walls, contains a door with tilting window at the top. Each second or third wall panel is fitted with a window opening inward, with removable wooden window frame. Simple mantel-stoves with iron chimneys and insulation are used for heating the barracks. The convenient use of the floor in packing up the barracks for transit makes it possible to carry three units in a single freight car.



Longitudinal and cross-sections of the new German "fire-stick", and diagram showing how it is used

A Wingless Seaplane Which Hunts the U-Boats

IN their submarine campaign it appears that the French are making use of a novel glider which so closely follows the lines of the usual seaplane that it may be considered as a wingless seaplane. This odd craft, which is depicted in the accompanying illustrations, apparently serves as a fast surface scout.

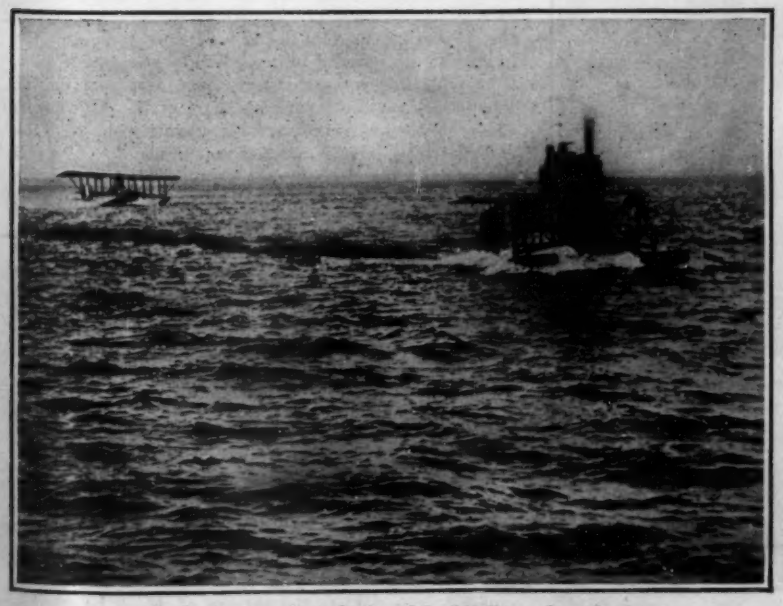
The wingless seaplane consists of two main pontoons and a tail float, supporting a framework which carries a two-passenger nacelle and the usual tail members of an aeroplane. The tail members are used for steering the craft. The power plant is placed at the forward end of the nacelle and drives a tractor screw. Capable of a high rate of speed, it is obvious that this wingless seaplane performs invaluable service as a patrol scout in the hunt for German U-boats, in conjunction with its aerial counterparts and surface craft. Because of its shallow draft and high speed it is practically immune from attack by U-boat, and it is quite possible that it may be used in a small sort of a way in attacking the periscopes of the German subsurface raiders, which probably accounts for the rifle held in the hands of the observer in one of the accompanying views. At any rate, the wingless seaplane appears to be a valuable adjunct in the U-boat campaign, for work in calm weather and in covering large areas.

Sweeping Out Captured Dugouts With a Broom of Fire

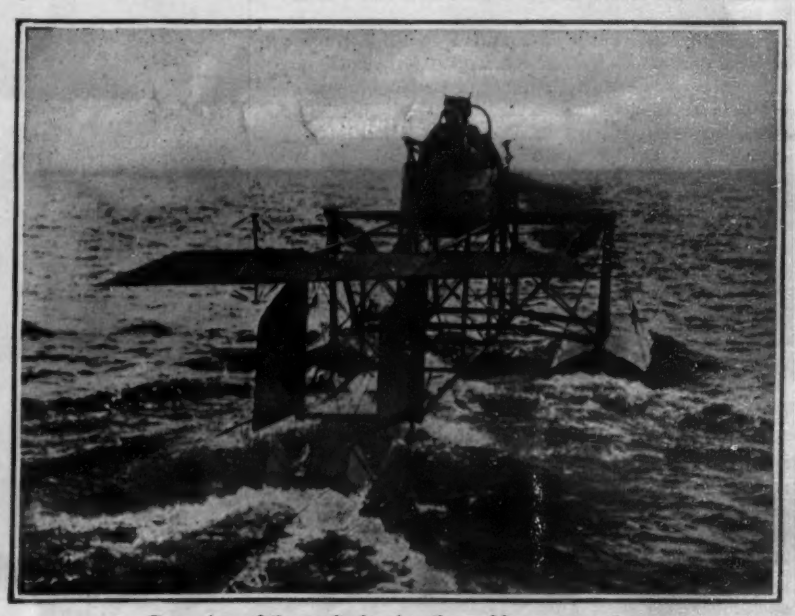
FOR some time past stories have been coming across the water of a terrible new engine employed by the Germans for the purpose of cleaning out the defenders of captured dugouts by subjecting them to a literal bath of fire. French raiders have finally come into possession of some of these, and we are able, through the courtesy of *La Science et La Vie* to illustrate and describe this latest addition to the horrors of the military deadlock.

The Brandrohr, or firestick, as the Germans call their new toy, consists for the most part of a sheet iron cylinder, which is found in two sizes—20 inches long and 4 in diameter, or 16 x 2. In both cases the metal is about one-twenty-fifth of an inch in thickness. This tube is closed at the bottom by a two-ply disk of

(Concluded on page 184)



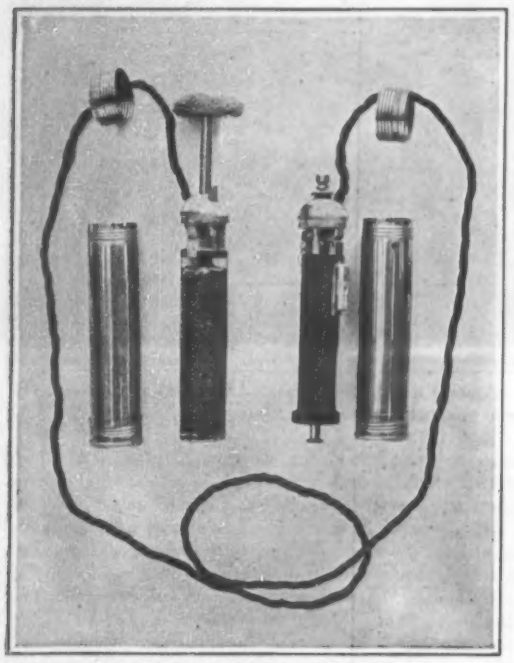
A wingless seaplane designed for hunting submarines



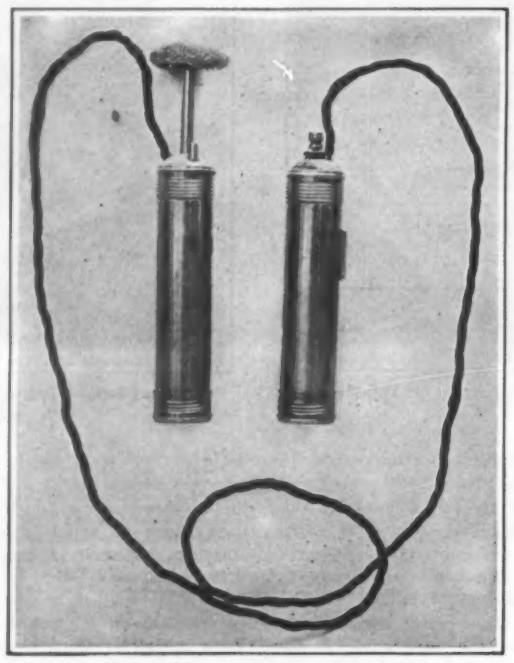
Rear view of the craft showing the rudder construction

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Arts



Components of the newly-invented, self-contained electro-therapeutic apparatus



The handles of this apparatus contain the current-producing means

Method of applying the sponge electrode of the self-contained apparatus

An Electro-Therapeutic Set Which Carries the Apparatus In Its Handles

CONSISTING of two handles or electrodes in which the current-producing apparatus is contained, a newly-introduced electro-therapeutic set can surely be said to represent the utmost in compactness.

The new self-contained set is the invention of A. Benko of New York city. Outwardly, it consists of two nickel-plated electrodes, provided with screwed end pieces and connected together by means of a twin-wire flexible cord. One case contains the battery, which is of the multi-cell flashlamp variety, while the other contains the induction coil with its switch, interrupter and intensity regulator. Ordinarily the set is operated so as to deliver the current to the two handles which are held by the patent; but when desired a sponge applicator may be used, in which event the manipulation of a switch at the top of the battery case causes the current to flow to the sponge applicator instead of to the handle. Obviously, the user continues to make use of the other handle, while applying the sponge electrode to any part of his body requiring treatment.

A peephole in the induction-coil case permits the action of the interrupter to be observed without disturbing the apparatus, and any adjustments which may be necessary can be made by means of a thumb-screw and lock-nut at the top of the case. The intensity of the current can be varied by having more or less of the bottom plunger protruding from the case.

How Tommy Swats the Fly

IN the early days of the Mesopotamian campaign it was no uncommon thing for both men and animals to be tormented to the last stage of exasperation by myriads of flies, which in addition to causing great physical discomfort were, of course, positively dangerous to health. Now-a-days, however, a vast improvement has been effected, the result of the enterprise, initiative and energy displayed by the entomologists and sanitary sections sent out by the British Government, and so eminently successful are the many ingenious devices for encompassing the destruction of the winged pests (not only in the mature, but also in the larval stage), that, with the exception of one or two isolated areas, flies are scarcely more numerous than at home.

A contributor in Mesopotamia sends us a photograph (which we herewith reproduce) of one of the most successful of the many novel death-dealing devices now in use and to which is undoubtedly due a large measure of the comparative immunity from fly-annoyance—and consequent diminution in fly-borne diseases, which the British troops have recently enjoyed. The apparatus is known as the "arsenite" fly-trap and, in principle somewhat resembles a roller-towel, which, by an occasional turn of the handle, revolves in a tank (improvised in this case from a petrol tin) containing a mixture of sodium arsenite and sugar, the moistened cloth proving a great attraction to the thirsty fly which rapidly succumbs to the effect of the poison.

This dining car gives the effect of private dining rooms

A roller-towel fly-trap from the Mesopotamian front

A Dining Car de Luxe

FOR years it has been generally accepted that the final type of railroad passenger car has been evolved, at least as far as the general principles are concerned. Recent innovations on one railroad, however, show that there is still possibility of improvement in this respect.

One of the new cars is a diner that gives a considerable degree of privacy to the patrons. Instead of having a double row of seats and tables along the sides, the car has seven compartments down the middle of the car, separated by partitions, with a passageway on each side. The diners are thus screened from each other, and in view only of those passing along the aisles; at the same time they have an unobstructed view through the windows. Each compartment has seats for four, and in an emergency for six. Part of the compartments are so arranged, however, that a stained glass screen parallel to the sides of the car may be dropped, making a private compartment for two. The car is all steel, well ventilated and lighted, and otherwise up to the modern standards.

Experiments with Skins of Five-year-old Fur Seals

A SUFFICIENT number of skins of five-year-old fur seals will be taken this season on the Pribilof Islands, Alaska, to enable the United States Bureau of Fisheries to determine fully how they will be received by the trade, and the best uses to which such skins may be put. As a preliminary step a St. Louis concern has forwarded to the bureau for examination the dressed and machined skins of three Alaskan five-year-old seals. These skins have about twice the area of the skins from an average three-year-old seal, and were regarded by experts as fully equal in quality to the average skin of the younger seals that have heretofore made up the quota for the natives' use. A limited number of skins from seals five years old were taken last year on the Pribilof Islands for experimental purposes. In view of the probable high market value of such pelts and the comparatively large number of male seals of this age on the islands, the Secretary of Commerce approved the recommendation of the Commissioner of Fisheries that the present experiment be undertaken.

Two expert seal skinners from Newfoundland and two sealskin specialists from the St. Louis concern will proceed to the Pribilof Islands for the purpose of assisting the agents and instructing the natives in taking and preparing sealskins. In arranging for the presence of these men on the seal islands during the present season, the bureau has had in view the modern requirements of the fur trade and the increased task that will be thrown on the local force when commercial seal killing is resumed.

The Toy Season Approaches

A WELL known advertising agency is looking for inventors of toys who are foot-loose. The Editor will be pleased to hear from patentees who have not tied up their manufacturing rights, and will forward all replies to this note to the concern of which he speaks.

"693 in 691"

(Concluded from page 169)

improperly supported she would break in two. Consequently, the measurements taken and the work done in faith that they were rightly made were of the utmost importance. Had the water been pumped out of the dock, leaving the ship supported, like a bridge, by her bow end and the overhang of the stern resting on the caisson shelf, nothing could have prevented the most serious damage to the hull.

But the engineers had discovered that the draft of the "Kaiser Wilhelm" forward was 4 feet less than her draft aft. As a consequence, as the water was pumped from the dock, the bow settled more than the stern and when she came to rest on the bottom of the dock on an even keel the overhanging stem had lifted from the caisson by 3 inches, making a most workmanlike finish to the whole undertaking.

The "Kaiser Wilhelm," 693 feet long, was docked in a 691-foot dock with clear daylight all around, although measurable by the span of a finger and too little, at the bow, to thrust a hand between concrete wall and stem of ship.

In view of the engineering difficulties surmounted with such nicety, and without any damage to the ship or dock, it is not difficult to find something less than forgivable enthusiasm in the very laconic foot note appended to the official report to the Bureau of Yards and Docks.

"The manager considers that the Construction Officer and his assistants in charge of this docking operation are deserving of praise for the skill shown in placing in the dock a ship which would ordinarily be considered at least 3 feet too long to enter."

The Multiple Arch Concrete Dam

(Concluded from page 173)

in the stream bed. There was a natural lake here, and on its shores was found the sand for the concrete. This sand was mixed with fine rock from the crusher in the ratio 1:3. The rock aggregate was not quite so convenient, a tramway being necessary for its transportation. Part came from a slide of granite rock about half a mile away, and the balance was limestone from the outlet excavation just back of the side near the northern end of the dam. Here a tunnel begins which, passing beneath the dam in an easterly direction, carries the water from the reservior to the power house by means of a four-foot steel pipe.

The forms for the dam were made from lumber obtained on the site of the reservoir. The sawing was done on the spot. The conifers in this vicinity are found in considerable size and quantity up to within a thousand feet of the mountain tops. The quality of the wood is none of the best, but it was deemed good enough for this temporary work. It was used green, and in order to prevent leakage of grout when shrinkage occurred battens were used beneath the sloping arches.

The spillway arrangements consist in the provision of a row of openings at the top of each of the two southernmost arches. The bottom level of these openings was made 2 feet lower in one arch than in the other. Loose flash boards provide for the closure of all openings. The plan in view is to close the whole spillway toward the end of the wet season and fill the lake to within a foot of the crest of the dam. The result will be the addition of 2 feet to the depth of the lake, or nearly 600 acre-feet of water.

On the same stream, at a point where the bottom of the creek bed is at a level some 500 or 600 feet lower, Agnew Lake dam has been constructed. This structure is 280 feet from abutment to abutment, with a height of some thirty feet. It is typical of the multiple arch dam located in a narrow cañon. The span of the individual arches is again about forty feet. The buttress structure has here a simple strut, instead of two, as at the Gem Lake dam. Two consecutive arches are provided as before with spillway openings, which enable the lake to be increased in capacity just before the beginning of the dry season. This structure is nearly sixty miles from the railroad station. The equipment and certain building materials had to be hauled this distance over rather steep roads through the desert. This situation is representative of a number of western hydro-electric developments. In some cases a railroad is constructed; in the development which includes Gem Lake and Agnew Lake dams, traction engines were employed. There were six of these, each able to haul three trailers and a net load of nearly 20 tons. The round trip from the railroad averaged about six 12-hour days. This period included loading, unloading and overhauling. When running at speed the rate of advance was two and one-half miles per hour; when this breakneck pace was not possible the train was slowed down to one and one-half miles per hour. The cost of such transportation was $13.50 per ton.

In comparing the costs of a multiple-arch dam and a rock-fill structure the expense of transportation is a very important item. In the case of Gem Lake, the 8,537 cubic yards of concrete were placed by contract at $22 per cubic foot. This included the transportation, but not the steel reinforcement, paid for at the rate of $110 per ton, in place. It is calculated that a rock-fill dam would have had to be constructed for as low a figure as $2.15 per cubic yard in order to have put its cost upon an equal basis with that of the multiple-arch structure. This could hardly have been done at the location in question.

The present instance is, however, an unfavorable one for the multiple arch dam, because of the excessive transportation costs. Not only was it necessary to haul all freight as described to Agnew Lake, but after reaching this point the items for Gem Lake had still to pass across Agnew Lake by barge and over two tramways to their destination. Naturally where transportation is less difficult and consequently less costly the expense of construction may often be cut materially.

Chemical Products From the Forests

(Concluded from page 173)

The smut prevailing in several kinds of grain not only decreases the yield of grain, but the dust from infected material has been the result of frequent and disastrous explosions in the operation of threshing machines. Formaldehyde has also been found effective in the treatment of scab and other diseases of the potato and cabbage.

These products from the destructive distillation of hard woods are absolute necessities and the importance of the industry makes independence of foreign supply imperative. Fortunately the smaller trees left by the lumberman and larger forms of sawmill waste are suitable for destructive distillation, and about 80 per cent of the raw material used by the industry is so-called waste. Beech, birch and maple have been the standard species and to encourage the use of wood waste the laboratory has made a study of the comparative yields of all the more important hardwoods. The investigations showed slabwood to give a slightly higher yield of alcohol and acetate than cordwood. Tanbark oak of California gave yields comparable to the standard woods, although heretofore only the bark of this wood was being used for its tannin content, and a study was made of the possibilities of the hardwood distillation industry on the Pacific Coast.

From a careful study of the operation on an experimental basis, it was found that by proper control of temperature during distillation yields could be increased considerably. The process was applied in commercial practice with an increase of 13¾ per cent in the yield of acetate and 16 per cent of alcohol, with also a saving in fuel, and over fifty per cent of the plants have already adopted this improvement.

Ethyl or "Grain" Alcohol from Wood

As long ago as 1819, Braconnet showed that wood could be hydrolyzed to fermentable sugars, and an immense amount of work has since been carried out on the industrial application of this discovery.

This stretch of concrete is in Erie County, New York, between Buffalo and Batavia. It was built by the State Highway Commission under the supervision of C. J. McDonough, District Engineer, Buffalo; Thos. F. Shaughnessy, Albany, was the contractor.

A Road Authority's Opinion of Concrete

LeRoy Ulrich, Superintendent of Repairs, Connecticut State Highway Department, Hartford, Conn., in a paper read before the American Concrete Institute, made the following statement:

"The construction of the first concrete road in this state was commenced in the summer of the year 1913. It was built to replace a worn out stretch of macadam, and the type was adopted for the following reasons:

"First: The amount of motor vehicle traffic was increasing as well as the carrying capacity of trucks. How far this would increase could only be inferred.

"Second: The increasing cost of the maintenance of the ordinary water bound macadam caused by these conditions was fast reaching a sum so great that sufficient money could not be obtained to properly take care of its maintenance.

"Third: The commission realized that to build roads which were not strong enough to withstand the future traffic was false economy.

"Fourth: The original cost of the type to be chosen could not be so high as to prevent a considerable mileage being built to replace the poorer types by hampering the construction of the new work.

"Fifth: Maintenance cost of the type chosen must be low in comparison with the original cost."

To which he added:

"The condition of these (concrete) roads in Connecticut at the present time would indicate that the traffic has had very little effect upon them and the maintenance cost should not materially increase for several years."

During the past two years, Connecticut has built over

Fifty Miles of Concrete Highways

CONCRETE ROADS:
THEIR ADVANTAGES

No Mud—No Dust
No Ruts—No Holes
No Slipping
No Skidding
Easy Hauling
Smooth Riding
Long Life—Safety
Always Ready for Use
Low Maintenance
Moderate Cost

the oldest part of which has averaged less than $40 a mile per year for surface upkeep. Compare this negligible figure with an annual cost of $585 per mile of all highways in the state. The low maintenance cost of concrete is no less remarkable than its extremely long life under the heaviest traffic.

This Association does not sell cement. It maintains a corps of trained highway engineers to cooperate with communities which want to build permanent highways. It has had nationwide experience in road problems and has gathered a fund of reliable information of great practical value to practical men. One of its experts will gladly call on you and consult with you about your particular problems. Write for Bulletin No. 136.

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No smoke—no jars—no cinders—just smooth, even, almost silent travel through the glories of the mountains.

So successful has been the operation of these electrified mountain divisions that work is well under way for the electrification of 211 additional miles through the snow-capped Cascades in Washington.

The future has indeed been made to serve the present.

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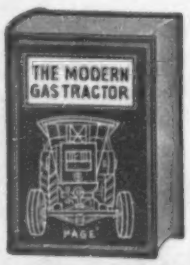

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In 1915 the Swedish Government published a report on the manufacture of ethyl alcohol and its use as a motor fuel was exhaustively treated. It was considered that alcohol denatured with 20 per cent benzol and costing $0.1978 per gallon could compete with gasoline selling at not less than $0.2739 per gallon.

Twenty gallons of alcohol per ton of dry coniferous sawdust is considered a very good yield, but the laboratory has succeeded in getting yields as high as 25 gallons of 95 per cent alcohol per ton of sawdust. On the basis of the semi-commercial experiments the cost of production would only be from 15 cents to 20 cents per gallon. The price of ethyl alcohol at present is 60 cents,* but conditions of course are abnormal and cannot be used as a basis for future operations. A shortage of gasoline will increase the possibilities of alcohol as a motor fuel. Small gasoline engines require about 1.8 times as much alcohol as gasoline per horse-power hour, but alcohol should be given higher compression than gasoline and by increasing the compression it is possible to obtain a more favorable comparison. As gasoline becomes scarcer and more expensive, alcohol as a motor fuel is bound to take its place. The production of alcohol uses grain, molasses, and wood that can be readily reproduced, while oil fields cannot be.

Venetian Turpentine

Very frequently materials have been imported when an equally satisfactory article can be obtained at home. As an illustration, Venetian turpentine may be cited, of which about 20,000 pounds are imported annually. Some time after the war broke out several inquiries were received from large eastern firms for a material to take its place. Their attention was called to Douglas fir turpentine which on trial proved to be "an excellent substitute." Formerly about 700 barrels of Douglas fir turpentine were collected annually, most of which was shipped to Europe; and no doubt some of this filtered back as "genuine Venetian turpentine" at a fancy price.

Osage Orange as a Dyestuff

Tehuantepec fustic wood was formerly laid down at Atlantic ports for $18 to $20 per ton, but after the war broke out the price doubled. For some time this laboratory had been calling attention to the fact that the osage orange of Oklahoma and Texas resembled fustic in its dyeing properties. The osage orange waste available amounts to 40,000 to 50,000 tons annually which is more than sufficient to repalce the domestic consumption of fustic. Texas osage orange contains 14.9 per cent of water-soluble extract, compared with 17.8 per cent in Tehuantepec fustic. A careful series of dyeing experiments conducted on wool and leather showed that the osage orange colors were equally as good as fustic with the result that the extract can now be purchased on the market.

Ordinarily we speak of what chemistry has done for forestry because it has in so many instance afforded a means of increasing the utilization of our forest products, but when these chemical products became a necessity it is very logical to reverse the order and speak of what the forests are contributing to the chemical industries.

Ninety Per Cent of Water

(*Concluded from page 177*)

with this; every thing not eaten fresh is dried, and stays dried till it reaches the consumer.

Another important feature is the economy in packing. Tin and glass are necessary to keep the water in saturated canned goods. They are not necessary to keep the damp air out of dehydrated foodstuffs. Much cheaper materials, in less wide demand for other purposes, will suffice for this. Transportation congestion will be avoided when it is no longer necessary for the grower to get his entire crop off his premises in a week, but can hold it until consumption catches up with him. Vegetables come to the drier direct from the field, with the dew on them, and are dried in all their pristine freshness and crispness, instead of after a night in the cars and a day or two on the stand or in the factory, as must always be the case with dehydration by the consumer and with the old system of factory canning. Other advantages will occur to the reader; enough has been said to place beyond all question the extraordinary interest of the subject.

In the SCIENTIFIC AMERICAN for March 10th appeared an account of one dehydration process which had just then reached development. An even more promising "machine" is the one now pictured. It represents, in at least one feature, a distinct advance over all predecessors. The chemist has so long been using the continuous chain process, where he has to deal with a long and slow reaction, that for him it has become a standard procedure. Better than in any general terms, what this process means can be illustrated by a description of the new dehydrator.

As always, the moisture is extracted by means of hot air, passed through the material under treatment. Only here, instead of being put, in bulk or in containers, into one large chamber, which is then exposed to the hot air drafts till the desired degree of dehydration is reached, this material is placed in comparatively small trays, say ten in all, arranged one above the other. The drying air, introduced at the bottom, passes up through this battery of trays, extracting moisture from the contents of each tray. But of course it extracts most from the bottom tray, which is accordingly finished first. At this point the nine upper trays are jacked up a bit, the lower tray removed, the upper ones eased down, and a new tray slid onto the top of the pile. The former second tray is now first, and so on up. The system is wholly elastic; size of trays, number of trays and number of batteries may be varied at will.

The advantages of this are twofold. After the two or three hours which are necessary to complete the dehydration in the lower tray, the process is a continuous one; fresh vegetables are going into the machine, and completely dried ones coming out, at 15 minute intervals for the balance of the run. Further, there is great economy of fuel. Under the single kiln system, the hot dry air which enters the kiln toward the end of the process frequently comes out no more than ten per cent saturated, since it nowhere encounters vegetables with anything like a maximum content of water. But under the system described, every thimbleful of air passes last through a tray which contains vegetables to all intents and purposes still fresh; and from start to finish all the spent air delivered at the top of the battery of trays is laden with moisture to the extent of its capacity. No air whatever is heated except to be used at maximum efficiency.

As for the rest, we can only chronicle the fact that the dryer pictured is right now in successful operation at one of the big North Jersey truck farms, drying potatoes and onions, cabbage and spinach, the beet-tops and celery trimmings already mentioned as one of the choice waste products of the vegetable garden, and any other items which are not salable at a fair price in the day's market. We illustrate its output under some of these heads; and we would go on record to the effect that they look as good in real life as they do in the picture, and smell better.

Making Food From Fodder

(*Concluded from page 177*)

the new source of foodstuffs is the fact that these food crops can be raised best in states which lie outside the wheat and corn belt proper, and so will not interfere with the production of those two important crops.

An analysis showing how feterita and other grains compare is most interesting, inasmuch as it shows that this hitherto little known product resembles corn in its composition and has a nutritive value practically as high as has corn. Experiments made in the South show that kafir

*Has increased since writing this.

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corn has a feeding value about 90 per cent that of corn, a rank to which feterita is also entitled. The following table gives the percentage content of corn, wheat, kafir and feterita:

	Feterita	Corn	Kafir	Wheat
Moisture.....	10.82	10.90	9.73	12.94
Ash.....	1.48	1.50	1.70	1.62
Crude protein...	11.50	10.50	12.69	13.94
Carbohydrates...	71.71	69.60	70.98	67.70
Crude fiber.....	1.15	2.10	1.38	2.24
Crude fat.....	3.34	5.40	3.52	1.56

Feterita is one of the newest grain crops introduced into America, having been brought to America about six years ago through the agency of the Department of Agriculture. While it has not been grown long enough to demonstrate its full worth and adapatability to American soils and conditions, it is evident that there is an increasing demand for it and that it soon will become a recognized farm staple, especially in the southwest, owing especially to its drouth resisting qualities. Feterita is somewhat softer than kafir and for this reason gives better results in digestion experiments. The harder grains such as kafir and milo will pop, and can be used in making excellent grades of hominy. The popped grains have a pleasing flavor. Feterita flour, however, has a much sweeter taste than kafir or milo.

The preparation of flours from these grains is a simple process, providing the grains have been well cleaned. After being ground in a mill, a bolting cloth can be used to produce a very fine grade of meal or flour. Practically the same process can be followed in preparing flours from the grain sorghums, although experiments of this character are not as advanced as in the case of feterita and kafir. The war is lending considerable encouragement to the study of these problems in southern agricultural colleges.

Scientific Headlight Control

(Concluded from page 178)

A car going only 15 miles per hour covers 22 feet per second. Accordingly it may run 100 feet with the driver practically blind. It is during this time that automobiles run into the ditch or strike pedestrians walking at the side of the road.

The real cause, then, of headlight trouble is the inability of the eyes instantly to adapt themselves to lights of different intensities. In perfect darkness a lighted match will glare; upon lighting a lamp the match ceases to glare and the lamp begins to do so; when a bright electric light is turned on the lamp ceases to glare, but the electric light takes up this office; when direct sunlight is admitted to the room the glare is transferred to this. On the face of things glare is elusive; but it is merely the effect of the presence of two lights one of which is much stronger than the other. It is a delusion to think of glare as an entity that can be eliminated from the headlight.

The remedy for headlight trouble, then, is not to be found in efforts to keep the lights from glaring; such efforts are futile. Rather should it be the object to keep the glare where it belongs—to prevent any light from one car from shining into the eyes of the driver of any other car. If this can be done, the objectionable part of the glare will be overcome, and the headlight problem solved. And it can be done, with ridiculous ease and simplicity. It will not be done, however, by reducing the strength of all headlights. Such reduction would affect equally the light reflected from the road; the light shining into a driver's eyes from a car approaching him would be just as strong, in proportion to that reflected from the road, as ever, and the objectionable glare would persist. The remedy must be sought in another direction. We must prevent the light from the approaching car from shining in our eyes.

Our first figure shows the lighting effect when cars meet under old methods. If all cars were going in the same direction there would be no difficulty; every driver would have his back to the light—to that thrown from other cars as well as from his own. This would be the ideal way of driving at night; but as it is out of the question to have two one-way roads, the next best thing is to make two one-way

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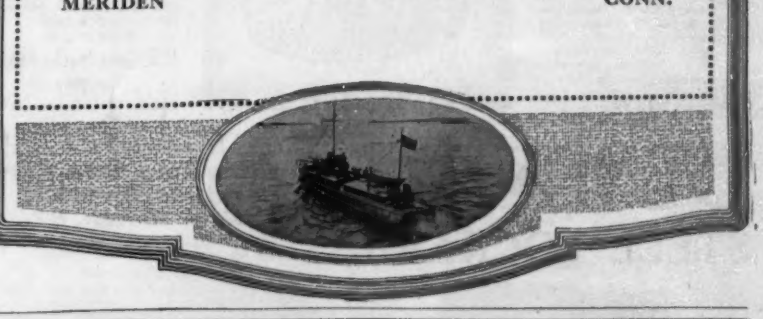

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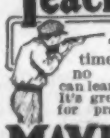

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roads out of the existing thoroughfare, so to speak, by dividing the light. This is easy enough; the next figure shows the effect which is sought. The whole road and its sides are brilliantly lighted far ahead, yet no matter how many cars there are on the road, or how strong the headlights are, no one who follows the rule of the road and keeps to the right has any light thrown into his eyes. And any car can be lighted in accordance with this plan at the cost of a few cents; there are no patents involved, no lenses to buy. The result is obtained by snugly and properly covering the headlight bulbs; and as far as lenses are concerned, a plain glass front is best.

All there is to do is to remove the bulbs from their sockets and paint them a solid dark green over part of their area. This shuts off all the light that would otherwise be thrown upon approaching cars. Experience alone will show what are the best angles to use in covering the bulb. We illustrate two arrangements which give complete satisfaction. For city driving the form shown at the left is good; in the country that at the right is perhaps preferable.

When the bulbs are placed back in the reflectors they should be so focussed that a fan-shaped light is thrown out. There seems to be great general ignorance as to how to do this. Explicit directions cannot be given, because all reflectors are not the same shape. The idea, however, is simply to move the bulb backward or forward a trifle until the desired distribution is obtained. We illustrate the three types which are possible; it is the fan-shaped distribution at the right which is desired, not the parallel beam or the directly divergent pencil. Usually a difference of no more than a sixty-fourth of an inch in the position of the bulb will make all the difference between the best and the worst. The previous cuts assume this type of focussing; covering the right side of the bulb cuts off the light that goes to the left, and leaves the beam from the left to go to the right.

When two cars thus lighted meet, the effect is as shown at the upper right of our large cut. It will be noted that there is a dark area in which both drivers sit. This, of course, makes all the difference in the world—it is just the difference between looking from a darkened street into a brilliantly lighted house, and the reverse. Really, no description can do justice to the lighting effect produced. It must be seen to be appreciated. It is possible in driving to light one side of a street car rail and leave the other half in darkness, or to produce the same effect upon a tree or a telegraph pole. The light thrown into the eyes of approaching drivers is so slight that it is a frequent occurrence for them to call out "your headlights are out." If a person standing at the left of the car, close against the mudguard, strikes a match, he can be recognized in this minute illumination from a distance of fifty feet, so complete is the exclusion of the light from the proscribed zone.

It is this type of lighting which has become legal in New York State. What the law demands is that the light be powerful enough to reveal any substantial object in the road 250 feet ahead, and that objects at the side of the car can be made out. What the law forbids is that the beam of light rise above a level of 42 inches anywhere at the left of the axis of the car. When this prohibition is met it is not possible to dazzle an approaching driver.

Attempts have been made to regulate headlights by keeping the lights below a certain level; but on the road this is not a success. For when an irregularity in the road raises the front of the car one inch, the light ahead of the car is raised two feet, which, unless the left side cut-off described is employed, will certainly throw it into the eyes of approaching drivers. Again, if a load is put on the rear seat which depresses the rear springs three inches, or if the rear tires become flat, the light beam at a point 250 feet ahead of the car will be raised six feet. This accounts for the experience of many motorists that headlights which were supposed to comply with the 42-inch laws are often worse to meet than plain lights. There is one sure way to comply with the New York laws and avoid blinding the occupants of an approaching car; and that is to cover the bulb as indicated above.

Sweeping Out Captured Dugouts With a Broom of Fire

(*Concluded from page 179*)

lead and iron, and is filled with compressed thermite. At the top it is sealed by a celluloid plate a sixth of an inch thick, with six vents and a central orifice for the insertion of a stopper. The latter is roughened, and fits so tightly that it can be withdrawn only by the aid of a thread twisted about it.

Now thermite is a close mixture of powdered aluminum and iron oxide which, at moderately high temperatures, supports a very brisk reaction. The aluminum is oxidized at the expense of the iron, the latter metal being set free and liquified by the very considerable heat which the action generates. The extraction of the stopper furnishes sufficient heat to start the ball a-rolling, the celluloid cap is quickly melted, and for about a minute the tube vomits flames which play to a distance of two yards from its mouth. This flame approximates the melting temperature of iron, and of course is very deadly in its effects.

By reason of this intense heat, the German soldiers are unable to hold the incendiary tube in their hands. They are accordingly obliged to throw it in somewhat the same fashion as a grenade, or, much better, to fasten it to the end of a long pole and sweep out the concealed corners with it, in the fashion shown on our cover. For clearing up captured trenches, it has no rival; hostile soldiers caught in the dugouts have only the two alternatives of surrender or death.

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Just then a young man stepped out of the crowd and offered his assistance.

"If your engine is all right," he suggested, "I think I can start it for you."

"Go ahead, if you can," urged the owner dubiously.

Picking up a jack, the young man raised one rear wheel from the ground and threw high gear into engagement. Then he turned the jacked-up wheel in a forward direction, being careful to pull up and lean away from the car. In an instant the motor was humming, and after throwing the gears into the neutral position and removing the jack, the friend in need smiled his appreciation of the owner's copious thanks and went his way.

It was a simple plan, as most successful mechanical adaptations are when demonstrated.

Early this summer a New England motorist found himself on the road several miles from any garage with a flat front tire and no jack. Noting a rail fence at the side of the road, he selected a straight, sound piece of timber. Next he built a solid pile of stones two and a half feet high in the road in front of his car. Then he laid the rail on the pile so that it made an angle of about fifteen degrees with the road, and ran his car up against the incline with sufficient force to raise the damaged tire clear of the road, and permit an exchange of rims. Having his rear wheels on solid ground, it was a simple matter to back off from the improvised jack when the repair was completed.

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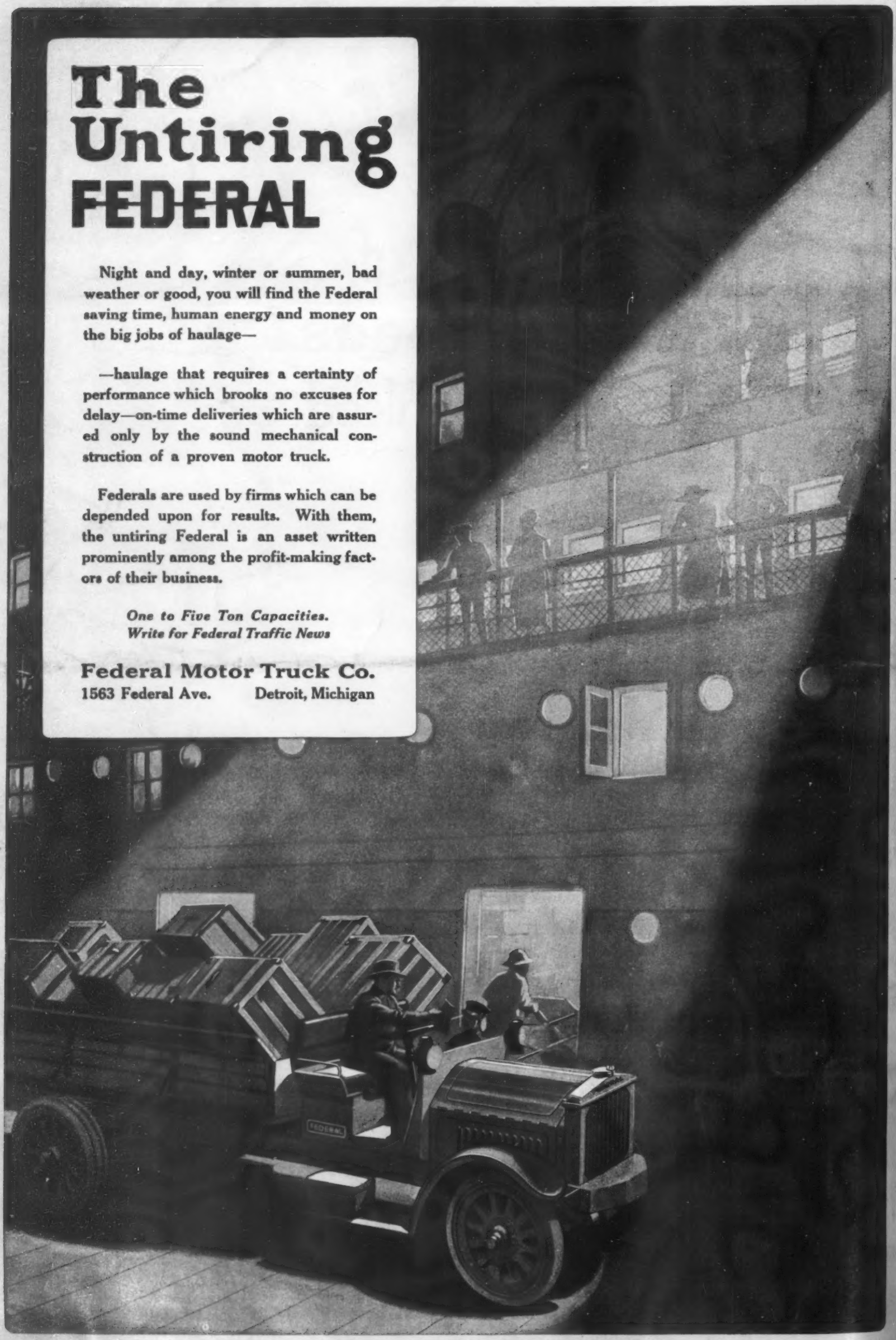

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"SHOOTING" THE PHOTOPLAY—PURSUER AND PURSUED TOWED BY THE CAR THAT CARRIES THE CAMERA—[See page 192]

September 15, 1917

Munn & Co., Inc., Publishers
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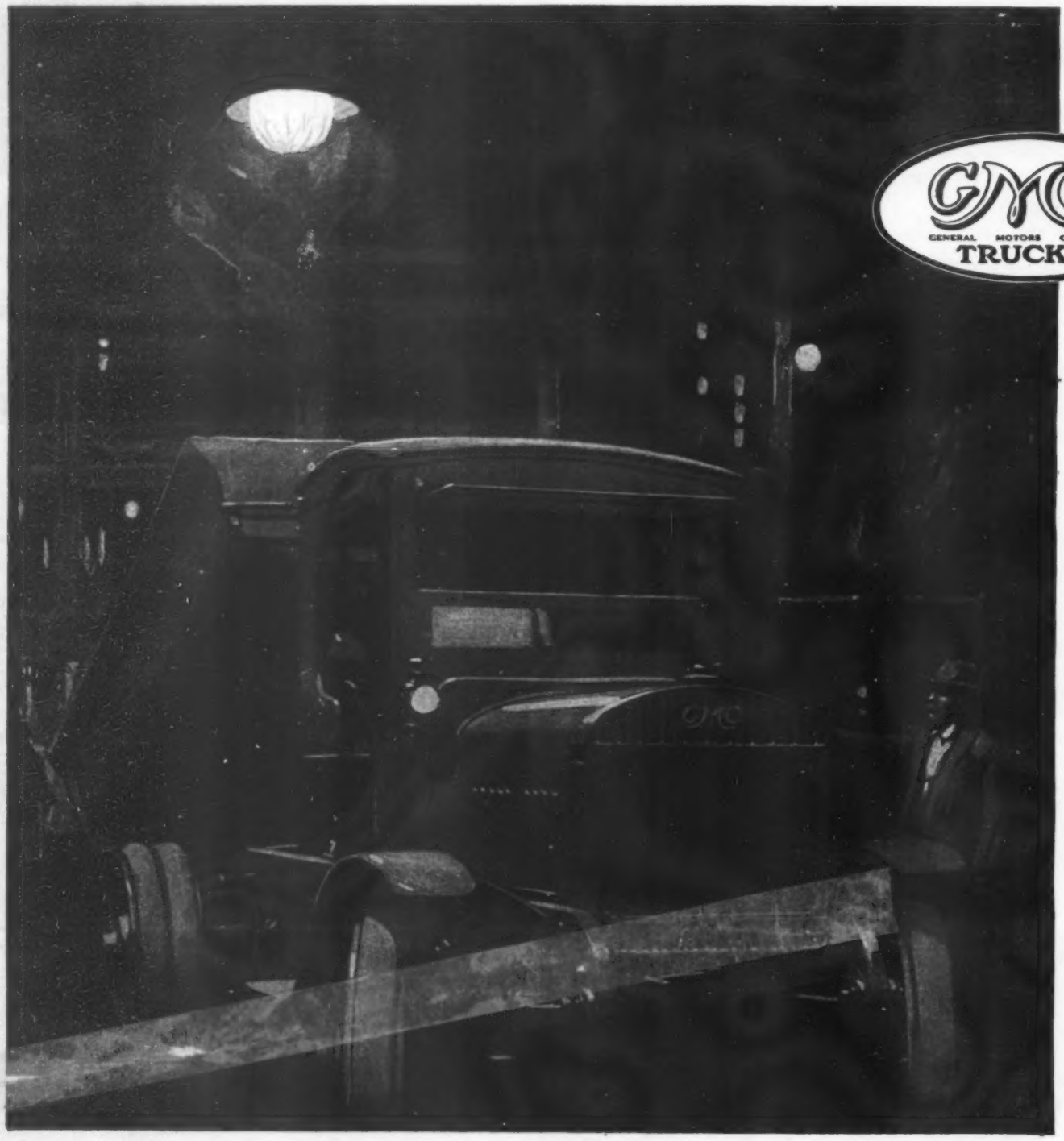

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